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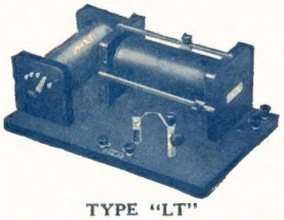

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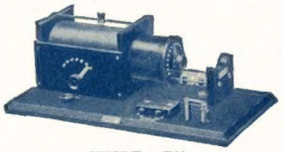

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U-53

MENE, TEKEL, UPHARSIN! Thou art weighed in the balances and art found wanting.

Thus read the fiery handwriting on the palace wall while Belshazzar was feasting and debauching. The last Babylonian king was warned, but like many others of his predecessors and many of his successors, he scorned the warning. His Kingdom had waxed rich and was bulging with treasures. But history all down thru the ages teaches us that when nations have too many treasures and when they enjoy too much prosperity, they grow less and less aggressive as well as less vigilant. As a rule the less fortunate nations are attracted by the riches of the treasure-nation, and one nice morning the latter is fallen upon and divided or else exterminated by the others.

The United States today is in no different position than was Babylonia under Belshazzar's reign. Like his country, the United States is probably the greatest treasure land of the times. But we are inclined to think that Babylonia was far better prepared to meet the onrushing hordes than we are today. Like the Babylonians, we have grown fat and rich and our vigilance has grown less and less as we have grown fatter and richer. Our army is spoken of in contempt by the great nations of the world, and if anything serious should happen to our navy—now but the fourth in size and power—a seasoned army of 300,000 men of any first-class power, landed on our shores, would conquer us in short order. So we are told by military experts, and there can be no doubt as to the logic of that statement if we but take our lesson from what has happened in Europe during the past two years.

Fortunately, our geographical position with large wastes of water on both sides of our country tends to protect us in a certain manner, or rather did tend to protect us until the invention of the submarine.

But since it has been shown how ridiculously simple it is to send naval submarines across the ocean, our former splendid isolation has past into history for all time. In the next war in which we will be involved—and no one doubts but that our turn will come next—submarines will play an even more conspicuous rôle than in the present war. That the great nations of the world will build entire submarine flotillas, far larger and better than the present ones, is an absolute certainty. The submarine has proven its worth, and while it may not decide wars, it certainly can raise tremendous havoc among an enemy.

Moreover, nations do not declare war as leisurely as was the fashion in the past. They aim to strike a vital blow first and declare war afterwards. The argument comes after the declaration, not before. Thus if an international crisis impends, it would be a simple matter to station a few hundred submarines in close proximity to our shores near the points where our battleships congregate, say at Newport News or at Narragansett Bay or any other important point.

At a given moment it would be easy for the enemy to approach our vessels at dawn and sink our entire fleet, or at least cripple it so seriously that we could not effectively prevent a landing. That would be the beginning of the end!

Let our pacifists who scoff at this idea reflect on just what occurred when the German war submarine—the U-53—suddenly bobbed up in the midst of our Atlantic Fleet but a few weeks ago. No one knew whence it came *and when it was to arrive.* Does it not send chills down our pacifists' backs if they contemplate that a *dozen* such submarines could have bobbed up just as readily—and with disastrous results—when we were in rather delicate relations with Germany not so many moons ago?

And would it not be an equally simple matter today for enemy submarines to enter nearly all our harbors and dockyards unknown to us? And how about Panama and Colon? Would it not be comparatively easy for an enemy U-Boat to effectively block the Canal by sinking ships at either entrance? Given certain circumstances, with the canal made impassable for our fleet, even for 48 hours, the consequences might prove disastrous for us.

Will we learn our lesson? Will we construct adequate defenses? At the present writing Canada already has taken due precautions. Thus Halifax for instance has protected its harbor by gigantic, sunken steel nets, suspended from floats. This perhaps is a fairly good measure to be taken in war times; it however does not lend itself well for a nation during peace times.

There are subtler and better means. As usual, electricity provides the means. We have a much better tell-tale if a submarine is approaching than steel nets.

A few dozen *Hughes-balances*—extraordinarily sensitive to approaching metal masses—can be sunk out of sight across the harbor entrance. At a central station every vessel can be detected instantly that passes over the line of these Hughes-balances. An observer who knows what vessels do or do not pass over the line will immediately detect an approaching submarine. A siren will announce the fact instantly to our vessels. No surprise attack will thus be possible. It is, sad to relate, very possible and feasible today. We invite our Naval Advisory Board to look into the merits of our suggestion.

The U-53 is our symbolic handwriting on the wall. Will we heed it?

H. GERNSBACK.

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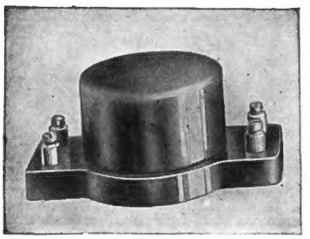

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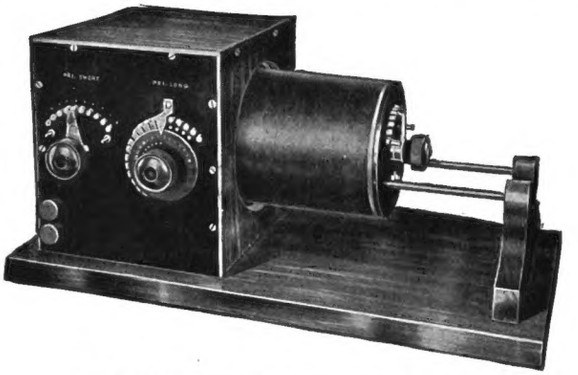

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THE ELECTRICAL EXPERIMENTER

H. GERNSBACK EDITOR
H. W. SECOR ASSOCIATE EDITOR

Vol. IV. Whole No. 44 DECEMBER, 1916 Number 8

Eyes and Ears for the Sub-Sea Fighters

By Thomas W. Benson

CAPTAIN KRONIG gazed with rapturous eyes at the highly polished mechanism fastened to the steel walls of his undersea craft. It had taken over a year of patient, scientific endeavor to evolve that apparatus and across his face there flitted for an instant the memory of the epochal day when he had gained permission to install it on his beloved ship.

"Eyes and ears," he whispered—"electrical eyes and ears for my pet; no longer must we crawl along in the dark towards a hidden death."

His reveries were interrupted by the chief engineer who entered the control room of the U-104 with an order in his hand.

Captain Kronig glanced at the paper and sighed a thankful "At last." He then turned abruptly to his engineer, inquiring curtly if everything was ship-shape.

A reply in the affirmative started the machinery of discipline into action and a half hour later the slim, cigar-shaped hull was gliding smoothly towards the open sea.

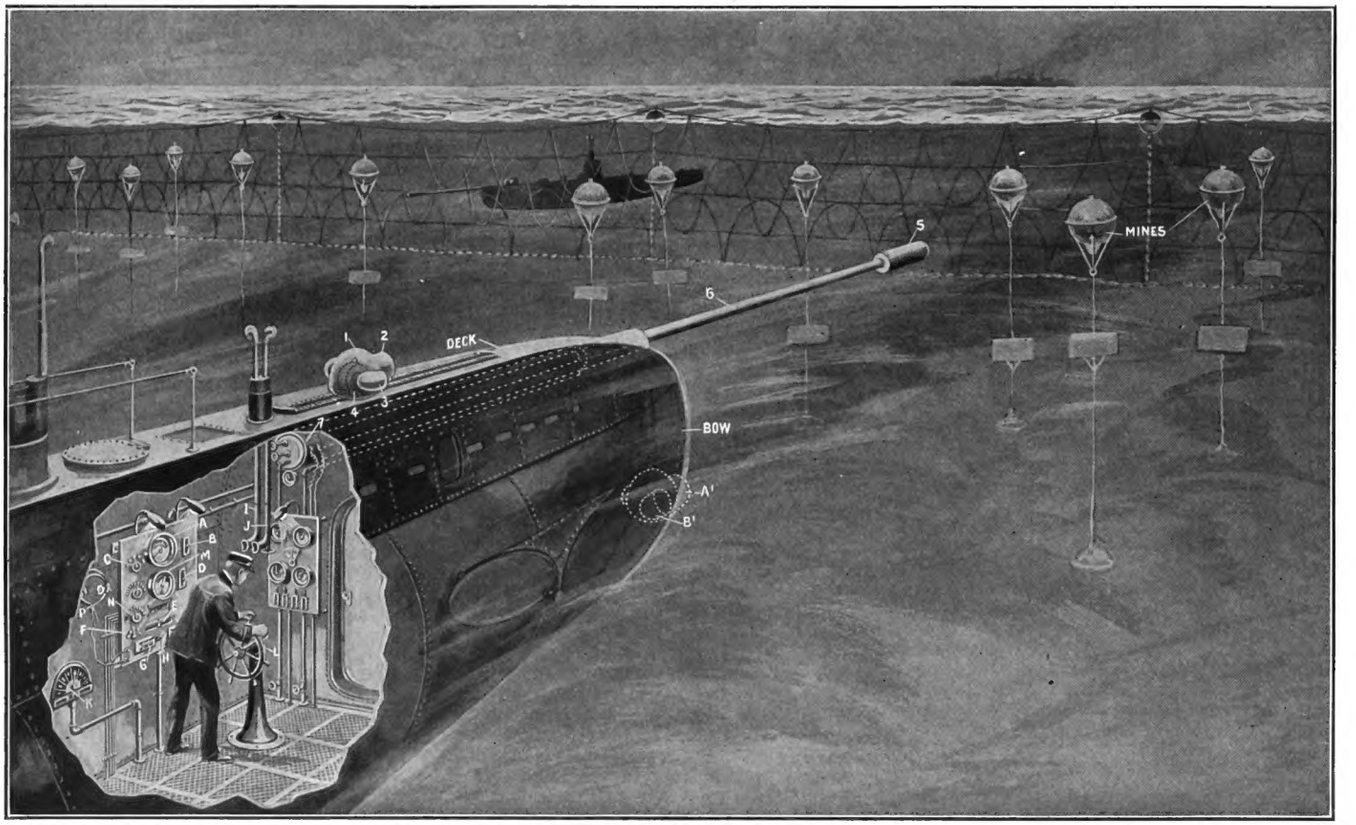
The U-104 was the youngest model submarine built for the German Navy and incorporated the latest and most wonderful *brain-kinder* of some of the Vaterland's cleverest and ablest engineers. It was, among other things, equipt with the new *electrical eyes and ears* that enabled the commander to feel his way safely among mines and nets. When it had been built matters not; suffice it to say it was an important arm of the powerful undersea navy of the Central Powers.

Later we find the U-104 off the west coast of Europe traveling northward with hatches open and the sea quite serene, except for a black smudge on the eastern horizon that indicated a tramp merchantman. But the game was bigger; the orders had read to report at Kiel and report they would, despite any ruler of the waves.

Captain Kronig was taking his position with the sextant and just as he had lined up the reflections on his screen he noticed a spot on the horizon that grew larger each second.

"Batten down the hatches!" he fumed, as he dashed to the conning tower while he threw his signal handle to the warning position and spun the wheel of his periscope. Three short minutes later and the tiny electric globes are glowing in the darkened steel chamber and the waves are splashing against the port-holes of the conning tower.

The *spot* had now grown until it revealed the shape of a fast patrol scout, bearing down on them at the rate of 45 miles an hour and as Captain Kronig got it lined up with the periscope a puff of white smoke appeared over its bow and



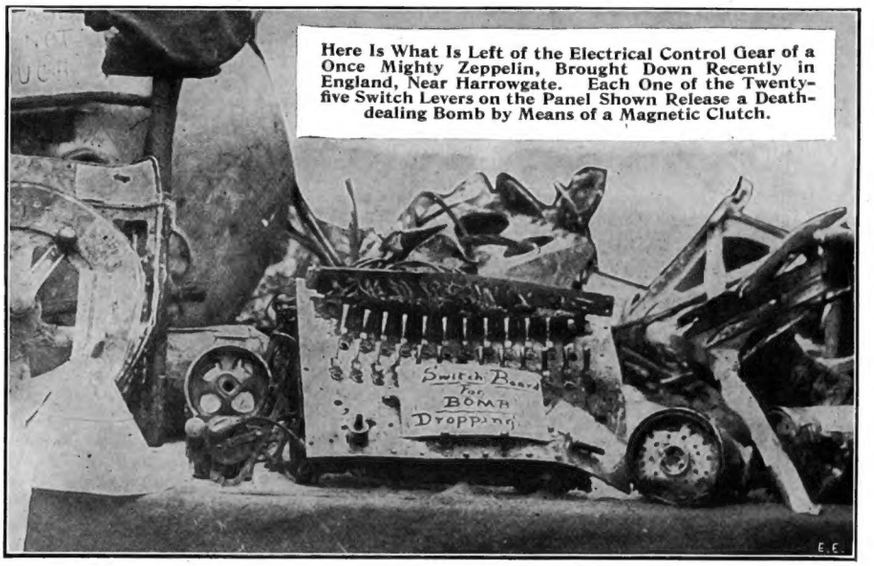
A New Electrical Scheme Intended for Use on "Submarines" Whereby These Wonderful Craft May Accurately Locate Nets, Mines and Other Submerged Metallic Obstructions. It Utilizes the Reflection of Sound Waves and the Hughes' Induction Balance in an Original Manner which Has the Ring of Plausibility.

SWITCHBOARD FOUND IN ZEPPELIN WRECK IN ENGLAND.

In a recent Zeppelin raid on England, the defending anti-aircraft gunners were lucky enough to "bag" one of these huge fighting demons of the air. As is generally known, electricity plays an important part in the maneuvering and general operation of all Zeppelin war-craft.

In the accompanying illustrations the switchboard used for bomb dropping is plainly visible, together with one of the magnetos used to furnish current for the ignition of the gasoline and air charges in the gasoline engines which propel the Zeppelin. Several other important parts of the control gear will be noted in the illustration, including the steering wheel and a signal lever projecting from its center post, this apparatus being visible at the extreme left of the picture. The magneto is directly at the left of the switchboard.

Some idea of the terrific concussion taking place when one of these fighting monsters of the sky is brought to earth may be gleaned from the picture.



Here Is What Is Left of the Electrical Control Gear of a Once Mighty Zeppelin, Brought Down Recently in England, Near Harrowgate. Each One of the Twenty-five Switch Levers on the Panel Shown Release a Death-dealing Bomb by Means of a Magnetic Clutch.

While the Teutons are extremely busy at this time in their everyday pursuit of military affairs they have taken sufficient time in which to develop a specially accurate means for waging aerial warfare from their giant fortresses of the air. The switchboard shown contains twenty-five levers, each one of which will dispatch a large bomb earthward, with its several hundred pounds of high explosive. The bombs are dropt from various points along the basket suspended beneath the Zeppelin gas bags, and by means of accurate sighting instruments the officers in charge of the bomb dropping can dispatch the missiles very close to the mark in most instances; or at least where there is not too much fog or intervening mist, which, of course, makes it very difficult to sight the various points on the earth or sea with accuracy.

The bombs are supported in a light cradle-like structure and when one of the switches on the control board here shown is closed, a quick-acting magnetic clutch releases the aerial projectile and it speeds earthward with rapidly increasing velocity—in fact, if it is dropt from a height of several hundred feet, it will have attained such a momentum and high velocity that if it should strike a building it will not only explode, but will, in many instances demolish the structure and pass clean thru it from attic to cellar. Some of these bombs have penetrated so deeply into the earth that they have never been found.

The Zeppelin and other aircraft of an allied nature as is now in use, has added a new phase to the warfare as waged by man. With these machines the great wars of the past, such as our own Civil War and the Spanish-American War, would have had a much different aspect.

---

a shell skimmed dangerously near. Another and yet another followed in quick succession just as the undersea craft obeyed the diving rudders and slipped beneath the waves.

Down, down, until the *submerged depth dial* before the navigator indicated 45 feet. Consulting the chart and the gyroscopic compass index the course was laid through the English Channel—through that veritable sea of nets and mines; but a glance at the marvelous, nay, almost supernatural, mechanism on the wall seemed to convey a feeling of safety to all of this heroic crew who braved any danger for the Kaiser and their Vaterland. Deutschland *under* the Allies!—that was their battle-cry.

They were rapidly nearing the forbidden ground, or rather scout, when Captain Kronig turned to his ever-faithful switchboard and rapidly manipulated several switches. He clapped on a pair of head 'phones and seizing a tiny projecting lever turned it down for a moment, then released it, watching intently the while a large dial just before him. The pointer sped around quickly and came to rest finally at zero.

"Gut!" he muttered, pulling another lever and the peculiar hiss of escaping comprest air was heard above the whine of the dynamo and the faint click-clock of a reciprocating pump. The snap of a switch sent home, the adjustment of another handle and Captain Kronig settled down to the precise maneuvering necessary to get through to Kiel.

With an alert eye on compass and depth gage, and a steady hand on the wheel, he would occasionally reach over and throw a switch or adjust a graduated handle. It was becoming monotonous, in fact wearisome, this crawling along at half-speed, this eternal handling of switches. So, eventually he relaxed a little as his thoughts wandered to a little cottage in the quaint valley of Genderen.

And with a suppress "Ach! Mein Gott!" his hand flashed to the switchboard and as the wheel spun violently under his mighty thrust, the hand of the indicator lever was thrown to full reverse, mingled with the sibilant hiss of air. A shock, as the mighty machine endeavored to check itself, the groans of powerful motors as they took up the load, only served to tense the men the more as they stood at their posts, ready to obey any order their doughty chief might give.

Kronig snapped that little lever on the switchboard again and again, watching intently the fast revolving finger on the dial. Then, slowly turning a knob, he glanced at a second dial, and his lips moved, framing an unspoken *hate!*

He had detected an enemy battleship and by maneuvering carefully by means of the switchboard dials, he had finally succeeded in passing it. A thousand yards beyond, according to his *log*, he signaled for a stop and ordering a rise to the surface, he stood motionless with his eye glued to the eagle-eyed periscope.

At first all was black, but slowly, gradually, the light began to appear and there, in the trough of a wave, he detected a huge green hulk. At last he made out the vast hulking form of an armored enemy cruiser and at the same moment they caught sight of his periscope.

"Ready!" was signaled his stern tube; *Full Speed* glowed the engine room indicator, and as the first shot rang out from the cruiser the U-104 dove. "Fire!" was flashed to the man behind the stern tube and like an automaton he pulled the lever that shot the tiny engine of death towards the big craft. Just as the diving rudders flattened out at 40 feet, a heavy shock was felt and the air of tenseness that had settled over the crew disappeared in an unanimous smile. *Another Britisher sunk by a daring submarine,* the papers would print the next morning. Meanwhile, the marauder crept north at half-speed.

Detecting and avoiding mines and nets was a continual experience. Being in the heart of the enemy's stronghold, it was necessary at times to creep beneath a huge ship of the first line; exchanging shots with a scout from the forward turret was an everyday occurrence.

Thus they journeyed northward and east, reaching at last the scientifically mined entrance to Kiel, the long-ought haven of rest, where they safely wormed their way along the narrow, tortuous channel to security.

As they glided into their stall alongside the rest of the submarine fleet, a mighty cheer went up for the daring men. Captain Kronig, standing in the conning tower, heard it, and smiled confidently to his lieutenant, who glanced thankfully at the marvelous switchboard below that had made such things possible.

* * * * *

"What scientific device made all this

(*Continued on page 609*)

DATE OF ISSUE.—*For the information of our readers, we wish to state that the newsstands have the journal on sale between the fifteenth and the eighteenth of the month in the eastern part of the United States and about the twentieth of the month west of the Mississippi River. Our subscribers should be in possession of their copies at these dates. Kindly bear in mind, however, that publications are not handled with the same despatch by the Post Office as a letter. For this reason delays are frequent, therefore kindly be patient and do not send us complaints as to non-arrival of your copy before the twenty-fifth of the month.*

A Giant Electric Torpedo That Eats Thru The Earth.

A GIANT torpedo that burrows its own way through the earth like a worm and can be exploded under any desired spot, has been tested on Staten Island so successfully that the government of one of the Allies now battling against Germany is negotiating with the inventor for its purchase.

The inventor is Clifford P. Marye, a civil engineer of New York. He calls it the "subterrane," because it may become to land warfare what the submarine is to sea-fighting. The idea is not entirely new, says the *New York World,* for it was partially developed many years ago as a possible method of tunneling, but was abandoned because much more expensive than the pick and shovel or the hydraulic shield methods. In modern warfare expense is no object.

Many creatures live underground and travel long distances by tunneling their way. The mole, for example, burrows a route through the earth with his powerful hand-shaped forefeet, and can progress underground almost as rapidly as upon the surface. But the mole digs his way and casts up the earth over him, as every gardener knows only too well.

An earthworm progresses through the ground in a different manner. It chews its way along, and passes the earth right through its body, only casting up such as it has to remove in making permanent tunnels.

The subterrane is said to be able to burrow its way through the earth almost exactly as does the earthworm.

The greatest difficulty in ordinary tunneling is the disposal of the earth as it is dug. The longer the tunnel, of course, the greater is this difficulty, as all the earth has to be hauled out the full length of the tunnel. Through soft earth it is possible to bore a tunnel as one bores a pencil through a lump of dough, removing nothing, but pressing the yielding earth aside and building up the tube behind the boring shield. In this way the Pennsylvania tunnels under the North River were bored. But such a method is useless in earth where there is much rock, gravel, boulder, clay, &c.

A torpedo to propel itself through the earth for any considerable distance must be able to go straight ahead, no matter what obstacles it encounters, and it must do this without removal of the earth behind it. In other words, it must eat its way through the earth; drawing this into its interior and passing it out behind, thus filling up the tunnel as it goes.

This is just what the subterrane does. The first one that was tried on Staten Island ate its way through sand and was dug out when exhausted. The second one ate its way into sand, earth and clay, in which were boulders, rocks and the roots of trees. It has never been possible to recover it, and it is still somewhere under the hills overlooking the Narrows. Of course these two experimental machines contained no explosives.

The Marye land torpedo, here illustrated, is a cylinder, forty feet long, eight feet in diameter, with small rigid steel fins standing upright all over its surface—these to prevent it from being deflected from its direct course by obstacles or changes in the character of the earth.

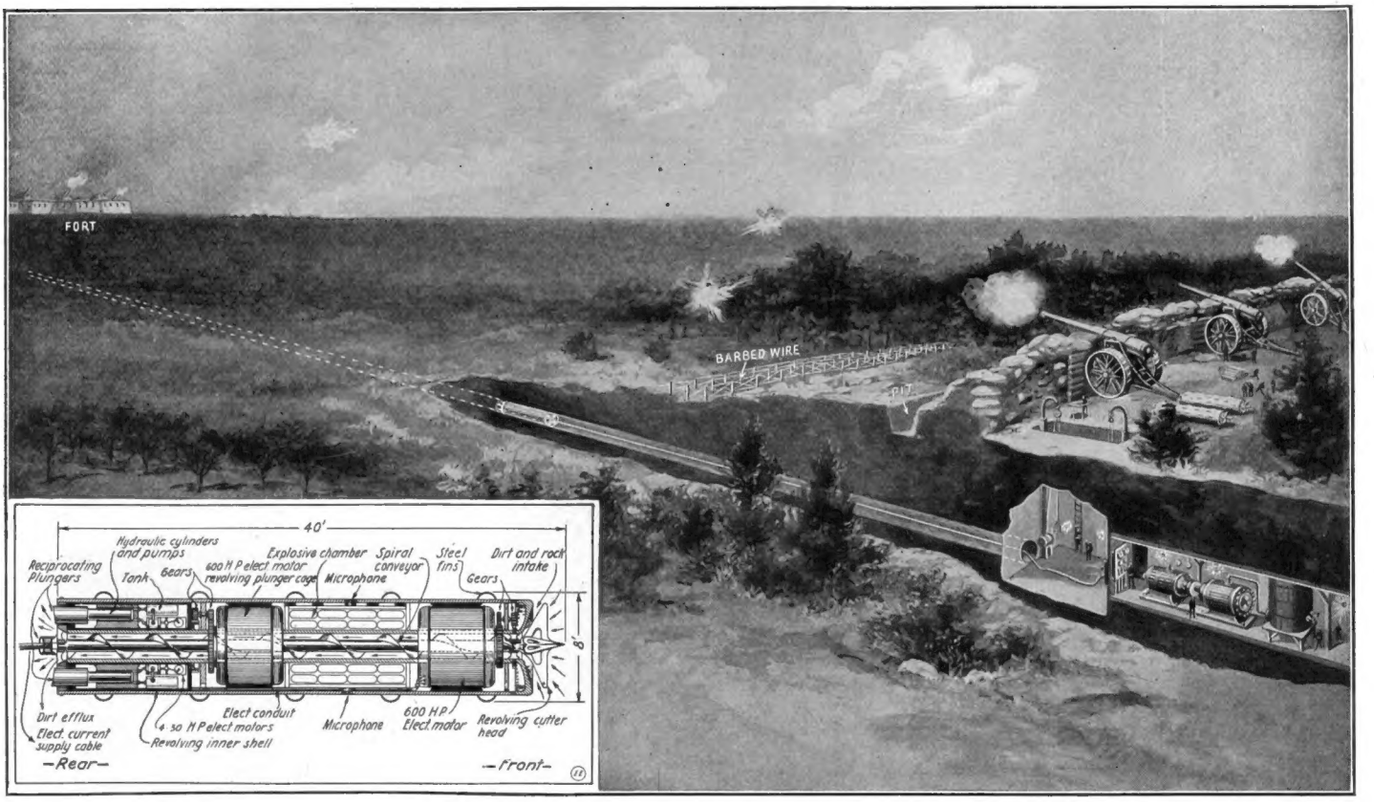
At the fore-end is a revolving cutting head the full diameter of the cylinder, working on the principle of a gimlet, with the additional faculty of grinding or triturating the earth and stones and drawing them back into the interior of the machine. Through the hollow center is a spiral that turns and passes the "digested" earth out to the rear. At the rear are four electro-hydraulic plungers which revolve intermittently, spreading the ejected matter evenly against the earth already there, and press powerfully against this mass, thus forcing the whole apparatus forward.

Within the subterrane are two electric motors of 600 horse power each, one of which moves the cutting head and spiral conveyor, while the other actuates the revolving of the plungers. In addition, there are four 30-horse power electric motors which work in concert through four hydraulic pumps and make the rear-end plungers behave like hydraulic rams. The whole is operated by engineers from a distance by means of an electric cable wound upon a drum in the subterrane and unwound as it progresses. This cable may be as much as five miles long. Through it the motors receive their power and the movements of the several motors are governed. Specially sensitive microphones are supposed to keep the engineers informed as to what progress is being made.

The explosion chamber is situated to the rear of the principal motors and is in the form of a ring, the full diameter of the subterrane, the spiral conveyor passing through its middle. It is large enough to hold 400 cubic feet of any explosive that may be employed.

The speed at which this war-monster can eat its way through the earth depends on the skill of its engineers, also upon the character of the earth—rock, for example, necessitating very slow progress. Mr. Marye says that from 40 to 100 feet an hour is the average. This progress consists of alternate forward movements and pauses; during the pauses material is accumulated and deposited at the rear.

(*Continued on page 590*)



Sectional View of the Latest Advance in Military Science—the "Subterrane"—an Electrically Propelled Land Torpedo, and Its Mode of Attack. It Can Burrow for Miles and When Under the Enemy's Fort, a Press of the Button, and the Fort is No More.

The Delineation of Internal Organs by A New Electrical Method

We have published the following article appearing in the authoritative "British Medical Journal" exactly as it was rendered in this well-known publication.

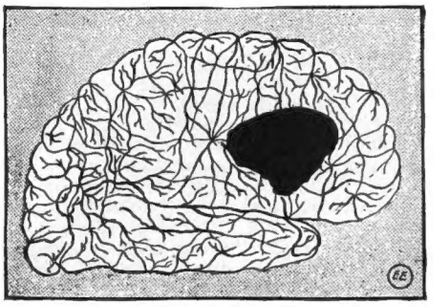


Fig. 2.—Brain Picture, from a Case of Gunshot Wound; It Shows Not the Brain Tissue Itself (which So Far, Has Not Been Found Possible to Delineate) But the Blood Vessels, and a Large Irregular Patch, Which is the Side of the Lesion. (This Picture Has For Convenience Been Printed Black on White. In the Original the Vessels Showed White on a Dark Background, and Near the Middle of the Patch Was a Small Dark Mark, which Was Believed to Be a Foreign Body.

It will appear to the reader that quite a good many points are difficult of reconciling with our present understanding of electricity, and we are equally certain that many must come to the rash conclusion that someone has been absent from the editorial office of the "British Medical Journal" when the article went to press.

Extraordinary as this account of the new discovery is, the reader should bear in mind that England at the present time is in the grip of war and that reporting from the front back to the editorial office is not always an easy matter, particularly when statements are made from mouth to mouth, instead of being written as is of course the case, in times of peace.

As for ourselves, we think it highly improbable that a picture can be made by electrical currents emanating from the blood vessels of the brain, or, at least, not by any ordinary or well-known electrical

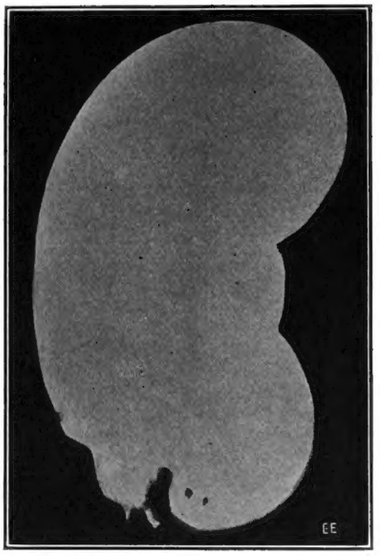


Fig. 1.—Picture of the Kidney, from a Case of Gunshot Wound. The Patient Presented Symptoms Pointing to Injury of the Kidney. The Picture Was Interpreted to Indicate a Wound of the Lower Part of the Kidney. Laparotomy Was Performed, and the Injured Kidney Removed. The Patient Recovered.

means as we understand them to-day.

Of course, the evidence in the pictures is here, but the reader should not forget that the result may have been obtained by means quite different, or as yet unexplained in the article in question.

Take, for instance, the following phrase from the article:

"The needle hammer mentioned is connected with a tiny circle to a carbon-like diaphragm of a telephone machine."

This certainly does not read as though someone thoroughly acquainted with electricity had written it. Furthermore, we have a lurking suspicion that where a diaphragm is used with a pointed stylus, the results produced thereby are probably caused by means of sound.

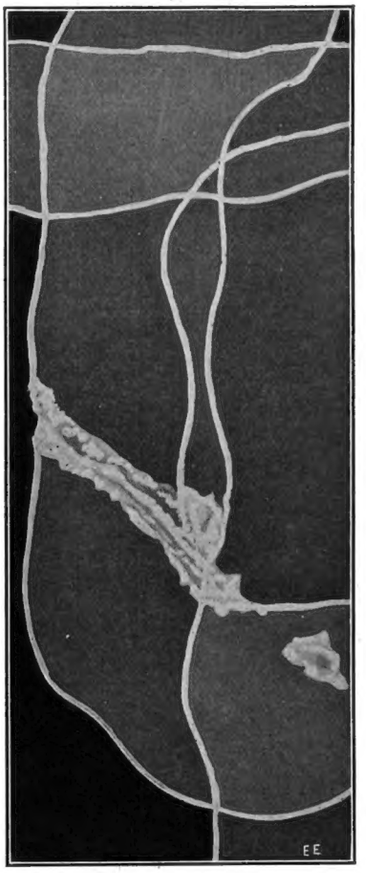


Fig. 4.—Injured Intestine. This Picture Shows a Portion of the Large Intestine Crossed in Two Directions by a Fold of Small Intestine Believed To Be Lying Behind It. In the Lumen of the Large Intestine is a Light Spot, which Represents a Foreign Body. The Wound By which It Entered the Intestine is Shown by the Oblique White Track Leading Down Towards It. The Correctness of the Picture Was Confirmed on Post Mortem Examination.

Take, for instance, Fig. 1, showing the injured kidney. That the kidney should practically photograph itself by its own electricity right thru the other tissues, ribs, etc., taxes one's credulity to the utmost.

Without, however, wishing to condemn the discovery, if such it is, of James Shearer, it will be necessary to await further particulars. We hope to publish during the next few months an exact account of how internal organs can be seen by other means than with the present X-Ray.—Editor.

THE manner in which the application of scientific methods to the medical work of the British Expeditionary Force in France is encouraged and the results obtained have been the subject of remark in various places, and several advances in medicine and surgery have already been recorded in the *British Medical Journal* columns.

No public statement, however, has any-

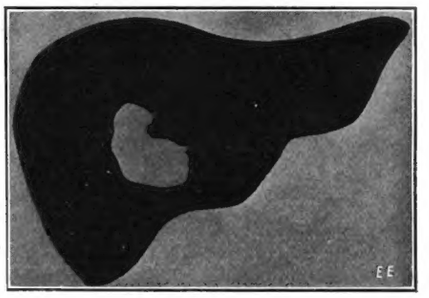


Fig. 5.—Picture of the Liver. This Man Was Wounded in the Axilla. He Was Found to be Tender Over the Lower Ribs. The Outline of the Liver is Shown, and in the Middle a Light Patch, Believed to be Pus, Surrounding a Foreign Body.

where yet been made regarding a piece of work of an unusual and somewhat puzzling character, which has been in progress at one of the casualty clearing stations in France for several months; though very quietly performed, it has given rise to a host of rumors, surmises, and conflicting views.

The first subject that it brings into mind is X-ray photography, and the next is wireless telegraphy. It soon, however, becomes apparent that the work, whatever its value, has no relation to either of these methods.

The new work, in fact, appears to succeed just where X-ray photography fails, or, rather, it takes up the task of producing pictures of structures hidden far below the surface of the body just at the point where X-ray photography ceases to perform it effectively. In other words, the new work attempts the delineation not of dense structures such as bone, but of living soft organs, such as the liver, the kidneys, and the intestines.

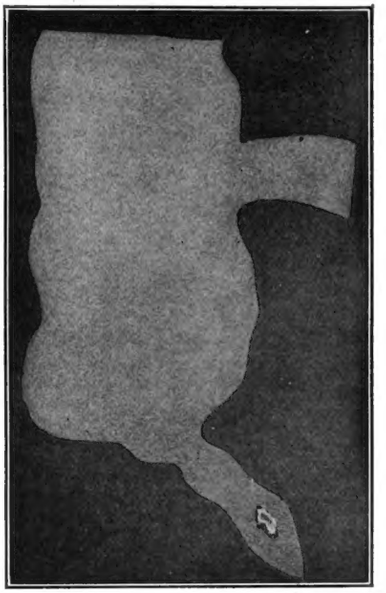


Fig. 3.—Picture of the Caecum and Appendix. In the Opinion of the Surgical Specialist There Was Absolute Correspondence Between the Clinical Diagnosis and the Condition Delineated in the Picture. In the Appendix may be Seen an Irregular White Mark, Believed to be a Concretion.

That circumstance in itself is sufficient to confer on the work a good deal of at-

traction, but what may be regarded as of still more interest is that it may be conceived as utilizing the electricity which is believed to be generated in the body (and to some extent in all living tissues, vegetable as well as animal) as a concomitant of the performance of ordinary life processes.

This new work, therefore, presents so many points of interest that, whatever the importance it may hereafter be shown to possess, it is desirable to endeavor to give some account of it despite the facts that its theoretical basis is not easy to understand, that it is very far from complete in respect of technical detail, and that the extent of any usefulness it may prove to have in practice cannot yet be defined.

What the work seems to do in its present stage is to enable it to be stated, without any manual or other examination, whether the more important viscera of a living patient—such as the liver, the kidneys, the spleen, and the brain—are intact so far as their gross anatomy is concerned, while at the same time it supplies evidence of any departure from the normal in the nature of a considerable enlargement or diminution in size, or an effusion of blood, or the presence of a foreign body, or the existence of a tear or cut of the visceral surface.

These things it does by providing pictures such as those here shown (see Figs. 1, 2, 3, 4, 5). One of these demonstrates a gunshot wound of the kidney; a second a gunshot wound of the brain; a third the caecum with inflammatory enlargement of the appendix, a fourth a piece of large intestine torn by a missile lodged in its lumen, and a fifth a traumatic abscess in the interior of the liver. All these pictures were obtained from living patients, and their accuracy was afterwards proved by a successful operation or otherwise.

It will be observed that they all present one common feature: the general outline is exceedingly clear, but no details are visible. The reason for this will be described later on.

The Visible Process.

The process of producing these pictures

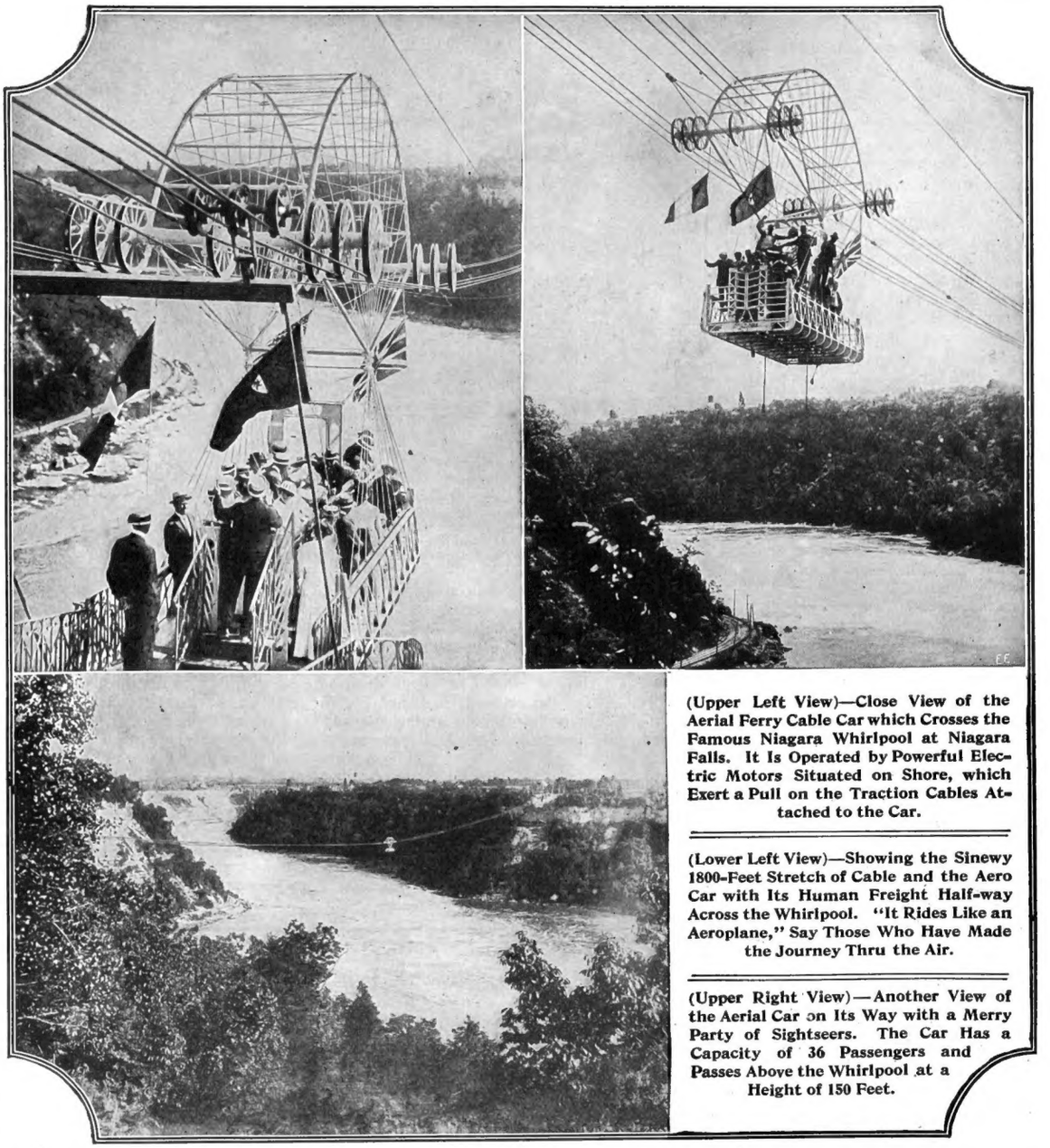
(*Continued on page 610*)

Electricity Guides Aerial Ferry Over Niagara Falls

THE Aerial Bridge here pictured, the greatest bridge of its kind in the world, which crosses the famous Niagara Whirlpool at Niagara Falls, is operated by electricity. The bridge was opened to the public for the first time recently. It is run on cable and gives the sightseeing folk a wonderful view of the falls and whirlpool.

Along the shore of the rapids on the right may be seen the gorge trolley route, which takes the visitors from Niagara Falls to Lewiston then across to the Canadian side and then to Niagara Falls, Ont., Canada. In crossing the whirlpool on the Aerial Bridge the roar of the falls is so great that conversation is almost impossible.

The aero car is run on steel cable lines 1,800 feet in length and is driven by a seventy-five horsepower electric motor installed on one of the banks where are also located the cable anchorages built out of concrete. At first the sensation is a peculiar one as the car starts on its journey of about one-third mile. The cables swing considerably and altogether the feeling created is that of riding in an aeroplane. Aerial railways such as this are much used abroad and this identical installation was suggested many times before the right man tackled it. The outfit is working admirably, the motion of the cab being very steady and the velocity has been figured out to be just about right for a pleasure trip of so novel a nature. Thirty-six passengers can be accommodated. The car is 150 feet above the whirlpool.



(Upper Left View)—Close View of the Aerial Ferry Cable Car which Crosses the Famous Niagara Whirlpool at Niagara Falls. It Is Operated by Powerful Electric Motors Situated on Shore, which Exert a Pull on the Traction Cables Attached to the Car.

(Lower Left View)—Showing the Sinewy 1800-Feet Stretch of Cable and the Aero Car with Its Human Freight Half-way Across the Whirlpool. "It Rides Like an Aeroplane," Say Those Who Have Made the Journey Thru the Air.

(Upper Right View)—Another View of the Aerial Car on Its Way with a Merry Party of Sightseers. The Car Has a Capacity of 36 Passengers and Passes Above the Whirlpool at a Height of 150 Feet.

Lightning completely volatilized 150 feet of wire on the Santa Fe-Cerrillos, Texas, telephone line recently, and burned the two poles at the ends of the wire, while three intermediate poles were left uninjured.

AMONG the hundreds of new devices and appliances published monthly in The Electrical Experimenter, there are several, as a rule, which interest you. Full information on these subjects, as well as the name of the manufacturer, will be gladly furnished to you, free of charge, by addressing our Technical Information Bureau.

An Electric Submarine Camera for Deep-Sea Photography

TESTS have been made during the past summer on board of the U.S. ship *Vestal* with a new device for deep sea photography known as an *Electric Submarine Camera.* This novel device, which works automatically under water, promises to open a new and tremendous field for scientific research—"the bed of the oceans"—because it is constructed to be lowered to great depths, 1,000 feet and more, and arranged to be controlled entirely from above the water. Our front cover shows the camera in use for the purpose of photographing a sunken ship.

This ingenious mechanism may also prove very valuable to the Navy, as sunken vessels can be photographed and their exact position and condition shown to experts on a projection screen in less hours than it would take divers days to ascertain, even if they were within reach of divers. This may in many cases thus help to save the lives of the crew of a sunken submarine or other ship, and what a boon to Treasure Hunters!

It was at Monte Carlo, the famous winter resort on the shores of the Mediterranean Sea, that Mr. Hartman conceived, several years ago, the idea to construct a device to photograph the unknown depths of the ocean, depths which will never be reached by a diver, and the thought to thus uncover the mysteries of the bottom of the sea, to see what no human eye ever saw before.

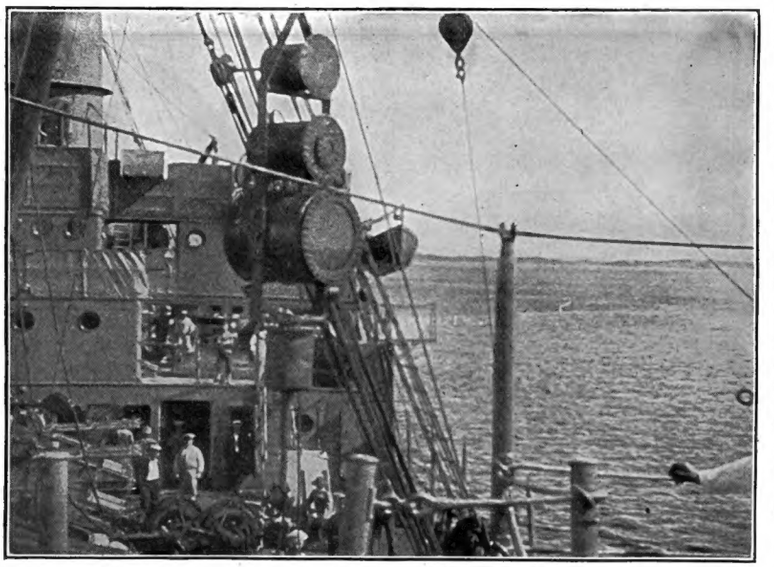
Prince Albert, ruler of Monaco and one of the greatest authorities on deep sea research, offered his help, having spent millions of francs on submarine research work and having collected every known device for this purpose in his magnificent "Oceanographic Museum," newly erected in a dominating position, high on the rock of Monaco. The Prince was enthusiastic over the idea placed before him by Mr. Hartman, and initial experiments were made at once, which proved very successful for depths to which sunlight penetrated into the water.

Mr Hartman needed a very powerful artificial light, special made lenses for his electrically operated camera, which can take a multitude of pictures at different angles and in every direction, and not finding there the necessary facilities to overcome these technical difficulties, he left Monte Carlo after six months of experiments in the Mediterranean and went to Paris, Berlin and London to consult with experts, to take out patents, etc., and finally, after the outbreak of the war, he returned to America.

Here he carried on further experiments and constructed a machine which is fitted with all features required for deep sea photography.

One can hear the mechanism working by means of a telephone from above the water. A device of this kind can be built to operate at any depth of water up to several thousand feet and Mr. Hartman declared that he could photograph the *Lusitania, Titanic* or other sunken vessels at any time.

There is no doubt that this invention will unveil many unknown depths of deep sea life, hydrographic and geological conditions, and it may disclose secrets and wonders of the immense depth of the ocean never before dreamed of. It is of interest that the Government, realizing the far-reaching possibilities of this device, has designated the *Vestal,* as the ship from which the tests are being made.



The Above Illustration Shows the Marvelous "Electric Submarine Camera" with Its Powerful Searchlight Suspended Above the Decks of the U. S. Ship "Vestal" Just Previous to Being Lowered into the Ocean. Its Inventor Believes that He Can Photograph Such Sunken Wrecks as the "Lusitania" and "Titanic," which Lie in Several Hundred Feet of Water.

The *Vestal* had been designated by the Navy department for carrying on tests with this novel device under the supervision of its inventor, Mr. H. Hartman, a civil engineer, of New York. There has never been such a powerful light produced under the sea before and at night it can be clearly distinguished to a great depth.

This device works under water absolutely automatically, and is controlled from above. It consists of a powerful, water-tight enclosed light projector, filled with nitrogen gas under varying pressure, according to the pressure of the water and having highly concentrated filaments. The glass lens is protected from the heat by an inner circle of transparent mica, having small openings to allow slow circulation of the heated gas. This light projector can be adjusted at will to different angles. The photographic camera, driven electrically, can take more than 6,000 stationary or motion pictures, with varying speed, all of which is controlled from above the water. A sensitive microphone, an electrical distribution board and the camera are installed in a special water-tight cylinder above the light projector and may also be adjusted or swung into different positions and under different angles independent of the searchlight.

Another feature of the invention is an electrically driven propeller which causes the whole submerged device to turn slowly around its vertical axis, so as to take panoramic pictures. Thus it is assured that anything within reach of the light and the camera will be photographed. The focus of the camera also can be automatically altered or caused continually to pass through the different phases, so that in such case a certain picture may be repeatedly taken and while some of those pictures of the same object may be out of proper focus, others may appear quite sharp and clear. The propeller and the focusing device can be operated or stopped at will from aboard a vessel from which the device is lowered into the water.

At the bottom of the entire device here shown, which is arranged within a strong skeleton steel frame, there is provided a shock absorber; this is attached to another cylinder above, which contains in water-tight cylinder a gyroscopic electric motor which tends to neutralize any undue vibrations of the apparatus. The electric current is supplied from the vessel by means of a flexible submarine cable, but the device itself, which weighs more than 1,500 pounds above the water and only some 100 pounds submerged, is suspended from a flexible steel wire rope. All the cylinders and other parts are made to withstand a pressure of 500 pounds and more to the square inch. Approximately a current of 100 amperes and 110 to 120 volts is required to operate the light projector and the different small motors. To counterbalance the loss of energy in passing through the long cable, about 50 volts more than stated above has to be added when the device is operating in great depths.

Referring to the illustration of the electric submarine camera here reproduced, the uppermost chamber contains the electric motor attached to the propeller used for orientating the device about its vertical axis. The next lower chamber contains the electrically controlled motion picture camera and its auxiliary apparatus. The largest cylindrical chamber carries the ultra-powerful searchlight. The vertical, small-size cylinder at the bottom houses the motor-gyroscope unit employed for stabilizing the outfit.

DO you ever wonder what the bed of the ocean looks like, or how a sunken wreck like that of the "Lusitania" or "Titanic" appears? At any rate these problems have so far baffled solution. For the purpose of photographing, either in motion or still views, such unusual and extremely valuable scenes, there has been perfected the "Electric Submarine Camera" described in this article. It is being tested by its inventor, a New York civil engineer, under the auspices of the U.S. Navy Department, and has given very promising results.

An electric room heater invented by an Englishman throws the warmed air directly toward the floor by means of a moving parabolic mirror.

Why a Mere Speck of Radium Costs $5,000

DID you ever stop to think why it is that a tiny speck of radium, half the size of a pinhead costs $5,000.00. It is because tons of ore are needed for the production of a grain of radium, and because many processes have to be gone through entailing enormous labor, that a milligram of radium was worth $120 at the latest quotation.

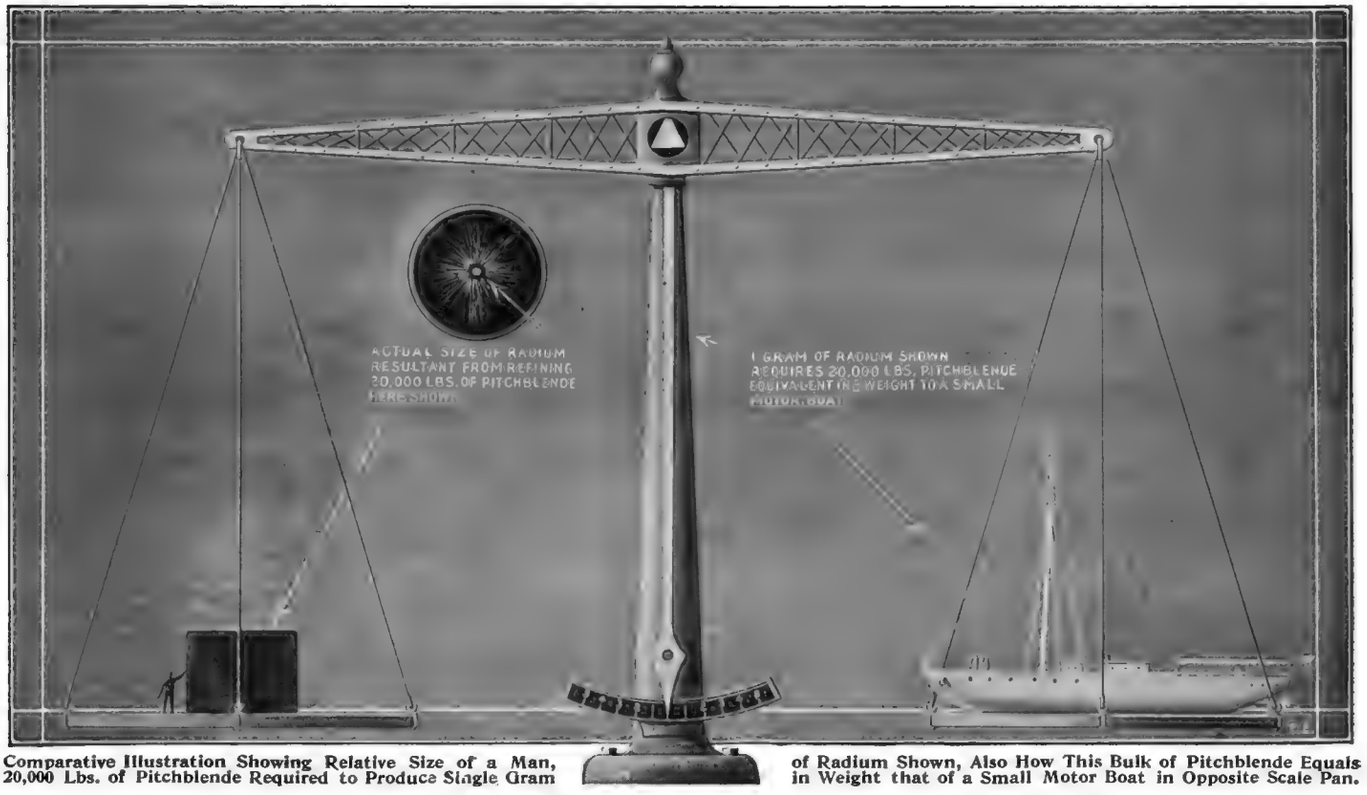
In 1910 it was estimated that there was only one-quarter of a pound of radium known to exist in all the world in the shape in which it can be utilized for medical purposes. A bit half the size of a pinhead is valued at $5,000, and from the point of view of cost of production it is worth it.

From the side of efficiency and force the value of radium is incalculable, for it is practically inexhaustible in the giving forth of energy. Strutt has calculated that one piece of thorianite was at least 280 million years old, and in all that time this radio-active substance has been giving off its energy. The life of radium is generally figured at 2500 years, according to Soddy. Various other figures give this value at anywhere from 1500 to 3000 years.

"Radium" Dial on Watch Glows in Dark.

It is a law of physics that energy causes energy, whether it shall be exprest in force, light, heat or electricity, all of which are interchangeable. The real problem before the manufacturer, or rather gatherer—for he can only concentrate, not make—of radium is to get out of a huge mass of radio-active ore the concentrated essence, or the combined radioactivity of the entire mass.

It is hardly twenty years since M. Curie and his wife discovered radium (1898), and possibly in the course of years more speedy and economical methods of extracting or concentrating radium will be found, but with all the improvements which have been made it is still a long, tedious and extensive process to be sure.


ACTUAL SIZE OF RADIUM RESULTANT FROM REFINING 20,000 LBS. OF PITCHBLENDE HERE SHOWN
1 GRAM OF RADIUM SHOWN REQUIRES 20,000 LBS. PITCHBLENDE EQUIVALENT IN WEIGHT TO A SMALL MOTOR BOAT

Comparative Illustration Showing Relative Size of a Man, 20,000 Lbs. of Pitchblende Required to Produce Single Gram of Radium Shown, Also How This Bulk of Pitchblende Equals in Weight that of a Small Motor Boat in Opposite Scale Pan.

Alpha, Beta and Gamma Rays of Radium, Indicated by Dots, Dashes and Curves Respectively. On the Left All the Rays Combined, then the Alpha Rays Stopt by a Thin Strip of Metal, then Alpha and Beta Rays Stopt by Thick Plate of Metal.

The United States Bureau of Mines has been operating for some time near Denver in a rich field of radioactive ore, Carnotite. Similar methods are used in Europe, tho improvements are being made as quickly as possible.

There are several methods in use but all require dealing with tons of ore to get minute quantities of radium finally. Some use first the acid leach*, others use an alkaline leach, followed by an acid leach, and then the ore must be fused with material which helps to break it up. The latest method utilizes nitric acid, producing a radium-barium sulfate.

The plant in Paradox Valley, Colorado, deals with carnotite, in which there is abundant a large quantity of uranium oxide.

To give an idea of the many processes thru which the ore must go before radium is secured, it is only necessary to go over a few details. The ore is first ground up fine, and then leached with strong, hot nitric acid. The product is next washed in a weaker acid solution, and again washed with hot distilled water.

When it has been filtered what comes thru the filter is diluted with water, and sodium hydroxid is added, so that radium-barium sulfate results. There is now still further treatment and then the sulfates are put into iron pans and dried in a hot air oven. Refining follows, yielding a sulfate free from impurities.

Then this is placed with carbon in an electric (or oil) furnace of special design and some of which consume several hundred kilowatts of electrical energy, and the sulfide is once more treated with hydrochloric acid, becoming radium-barium chlorid, from which the barium chlorid is extracted by (*Continued on page 590*)

Actual Photograph Showing Size of 2½ Milligrams of Radium, Worth $300.00, in Glass Tube.

Leach. To pass water thru ashes to form lye.

Guiding Trains By Telephone

By W. A. Wolff

IF the unforeseen never came to pass upon a railroad, instead of coming to pass nearly every hour of the day and night—there might be no such officer as the train-dispatcher, and no great need for telephones along the great steel highways of our country. But the emergency, the special, unusual case, does arise so often in the handling of trains—our great systems so swarm with limited flyers, fast freights, extra sections and private specials—that the guiding of trains to-day is a titanic task, requiring the best of efficient equipment *plus* brains and steady nerves on the part of the train-dispatchers and operators.

Go back to the early days and of course you will find no complexities in the directing of trains. Primitive railroading was an extremely simple proposition.

When the first really successful locomotive, capable of pulling cars was started on the Baltimore & Ohio lines in 1839, the problem of dispatching the train was simply one of making sure that the track was clear as far ahead as the engine driver could see. The train started when it was ready and reached its destination when it got there. There was no schedule and there could be none because of the uncertain operation of the locomotive mechanism.

However, when the railroad companies began to run two trains on a single track road at the same time, starting from opposite ends of the line, it became necessary to devise a scheme for keeping the trains from meeting each other head-on or else meeting at some point where neither could pass the other. To avoid these things, trains were run on the "time interval" system. Old railroaders will remember this as the system under which the ruling train had the right of one hour against an opposing train of the same class. If the latter did not appear within the hour, the train left the siding and went on, sending a flagman some distance ahead as fast as his legs could carry him, to flag the opposing train. When the two came within sight of each other, one of them had to go back into the nearest siding. Obviously, a great deal of time was lost with this very crude system if trains were late—a not uncommon occurrence.

During the year of 1850, a successful experimental campaign was carried out on the Erie, in an effort to telegraph train orders to trainmen and conductors from a central point, and from that time until the latter part of 1907, practically all train movements were directed by means of the telegraph.

Conductor Using Portable Telephone to Report the Delay of His Train.

The introduction of the *telephone* into the world of business resulted in its speedy recognition as an indispensable asset in the successful economic and efficient conduct of both large and small business undertakings. There was, however, one essential thing lacking, without which the maximum benefits obtainable in a commercial telephone system could not be secured in connection with the handling of train movements. This one thing was a means of calling, quickly and reliably, any one of a number of way-stations located in a dispatching district or division, without interfering with any other station in that district.

The *selector* was the result.

The telephone train dispatching line is nothing more nor less than a party telephone line extending from the dispatcher's office to the various way-stations on his dispatching division. It consists of a metallic telephone circuit to which certain calling apparatus is connected at the dispatcher's office and an individual selector at each of the way-stations, in addition to the telephone apparatus. The calling apparatus at the dispatcher's office is so arranged that a predetermined number of electrical impulses may be sent out at will to signal any one of the way-stations. This apparatus consists of a key cabinet, placed within easy reach of the dispatcher, in which there are a number of keys, one for each of the way-stations. These keys are so designed that the number of impulses sent by any one of them will actuate the corresponding selector at the way-station that is wanted. Therefore, when the dispatcher operates a key, only that station is called, as the selectors at the other stations are so arranged that they will not respond. The average time required for the dispatcher to call a station is approximately three seconds.

The flexibility of the telephone system also makes it possible to secure additional through telegraph and telephone circuits between terminal points or division headquarters without the expenditure of a single dollar for increasing the outside wire plant. This may be accomplished by *simplexing* and *phantoming* the train dispatching circuits.

A simple circuit is a telegraph circuit obtained by connecting repeating coils or retardation coils to the telephone circuit. These coils make it possible to carry on simultaneous telephone and telegraph communication over a single pair of wires without interference.

A phantom circuit is a circuit obtained by connecting repeating or retardation coils to two existing metallic telephone circuits in such a manner that a third through telephone circuit is provided over the two pairs of wires. In this way, three telephone conversations may be carried on at the same time over the two original circuits. Practically every railroad having message or commercial circuits paralleling their train dispatching lines is utilizing these wires to

(*Continued on page 590*)

A Switch Tower Out on the Line—Operated from Orders Received by Telephone.

A Message Operator Assisting in Train Dispatching by Telephone.

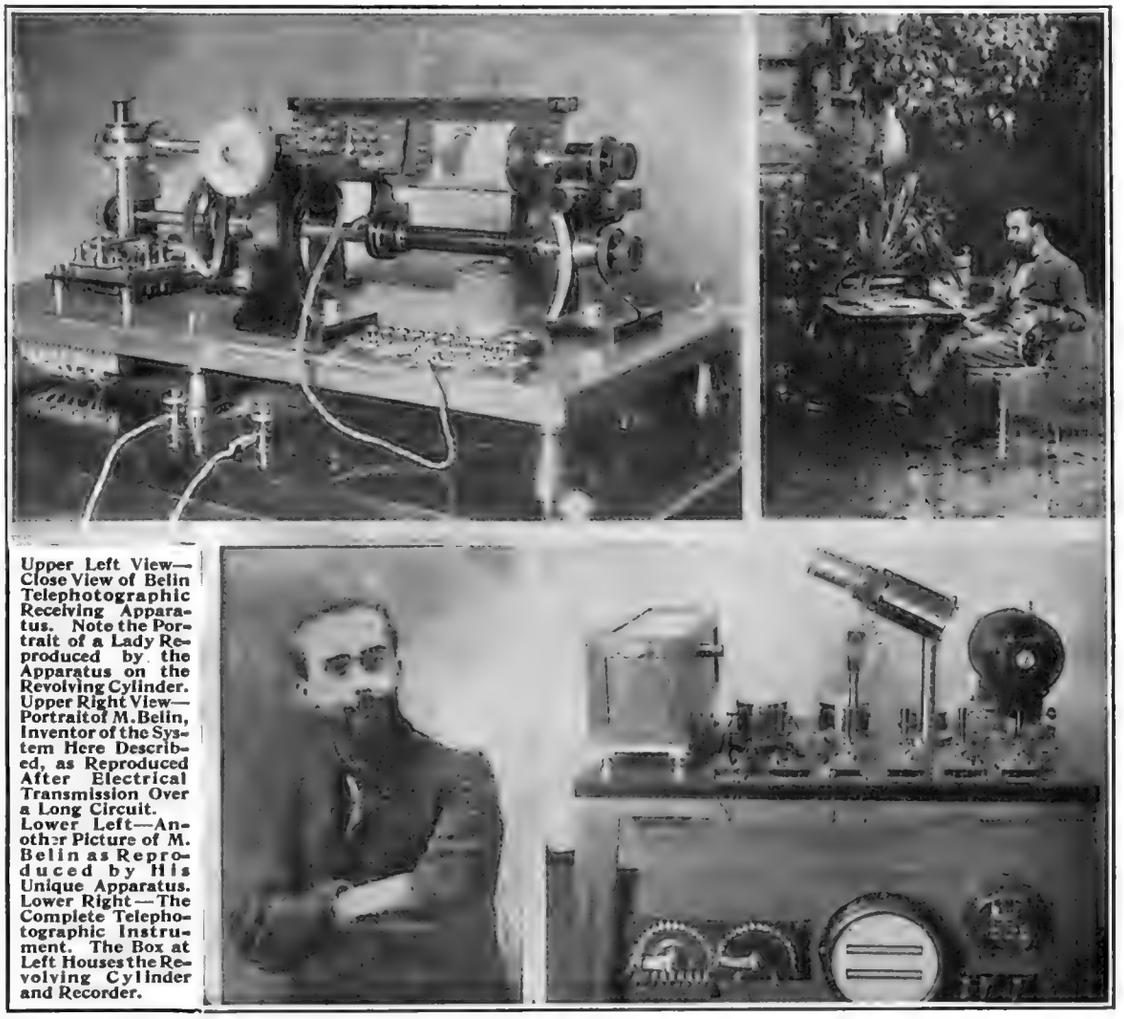
Transmitting Your Photo Over a Wire

By Jacques Boyer

Paris Correspondent of "The Electrical Experimenter"

THE possibility of transmitting a photograph or drawing over an electrical circuit was early recognized and even as far back as 1855 there were attempts made to solve this interesting and baffling problem. Experiments were made in 1855 and later notably by l'abbé Caselli (a French priest), by de Meyer in 1869, d'Arlincourt in 1872, de Cowper and M. Senlecq in 1879, Professor Korn, of Munich, in 1907 and of late Edouard Belin. The latter investigator of the problem spent much time and study on the subject and his perfected apparatus for accomplishing the purposes set forth was evolved in 1909. Several illustrations are presented herewith showing the appearance of the Belin transmitting and receiving apparatus, also the highly efficient results obtained in transmitting his likeness over a copper wire many miles long by a series of rapid electrical impulses.

The lower right view shows the complete Belin *Télestéréographe* apparatus; while the upper left view is that showing a close view of the receiving instrument. The reproduced portrait of a lady may be plainly seen on the cylindrical drum. The remaining two photos are those of M. Belin as received over an electrical circuit.



Upper Left View—Close View of Belin Telephotographic Receiving Apparatus. Note the Portrait of a Lady Reproduced by the Apparatus on the Revolving Cylinder. Upper Right View—Portrait of M. Belin, Inventor of the System Here Described, as Reproduced After Electrical Transmission Over a Long Circuit. Lower Left—Another Picture of M. Belin as Reproduced by His Unique Apparatus. Lower Right—The Complete Telephotographic Instrument. The Box at Left Houses the Revolving Cylinder and Recorder.

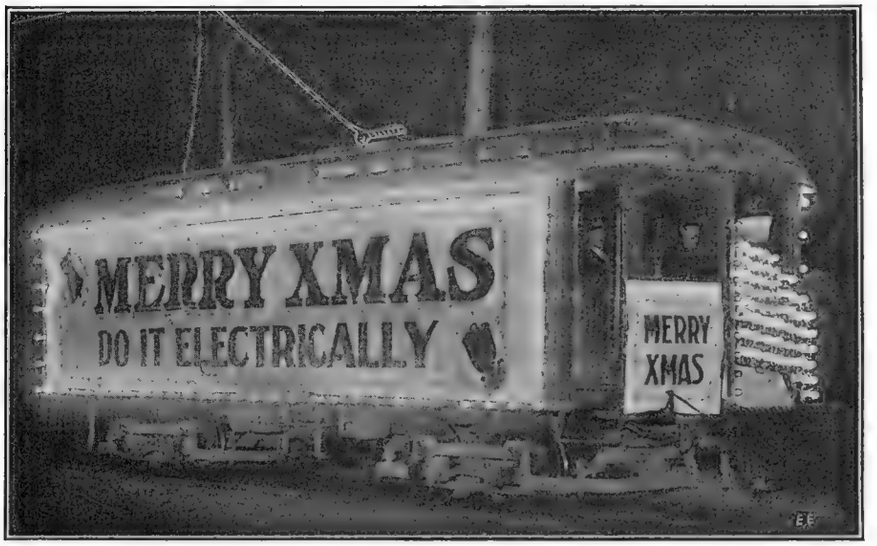
Primarily the system of M. Belin is based upon the principle involving a revolving cylinder at both the transmitting and receiving stations, these cylinders being electrically or otherwise controlled so as to both rotate synchronously or at exactly the same rate. This is essential in practically all telephotographic schemes. The photograph to be transmitted is transferred or copied on heavy photo paper and the proof so obtained is prepared according to the process of Poitevin, known as the procédé "au charbon," which is a photographic paper made with gelatine bichromate. This has the property of becoming insoluble in water when it is exposed to the light. Once removed from the printing frame it is washed in warm water and the gelatine is dissolved more or less, according to the varying degrees of opacity of the different parts of the negative. Finally there is obtained a proof representing in relief or having raised and sunken portions corresponding exactly to the varying gradations of tone in the negative. These variations in the physical surface of the prepared photograph are scarcely perceptible to the touch but are, nevertheless, of sufficient magnitude to affect a very fine sapphire point. This exploring sapphire point is attached to a stylus which is pivoted in front of the revolving transmitting cylinder around which the relief print is stretched. This arrangement is thus capable of registering the varying relief hills and valleys of the picture and transmitting these faithfully in the form of undulating electric currents over a telephone circuit, etc., in virtue of the fact that one end of the stylus is joined to a variable resistance device. Each varying tone of the photograph thus causes to be sent out over the line to the receiving machine a certain strength of current. Moreover, the transmitting cylinder gradually moves past the sapphire point, being mounted on a threaded shaft. This accounts for the fine lines seen in the photos reproduced herewith. The process, however, takes but little time to perform the necessary steps in transmitting and recording a photo.

Coming to the receptor apparatus, we have a Nernst lamp projecting a luminous ray onto the tiny mirror of a Blondel oscillograph. The mirror element carries the looped current wires of the oscillograph and which is placed in the powerful magnetic field of two electromagnets excited from a direct current source. Hence the movements of the small mirror will be proportional to the intensity of the current transmitted from the sending machine. The light ray projected by the Nernst lamp is reflected from the movable mirror, passing through a convergent or double-convex lens, against which is placed a tone screen, composed of glass strips cemented together, each strip being of a different value running from dead black to full transparency (i.e., from right to left). According to the zone through which the reflected oscillograph light beam projects, the ray is tinted more or less but no matter on which part of the tone screen the ray falls, it is always focussed back by the convergent lens on to the same fixed point in front of the revolving receptor cylinder. The ray of light passes through a minute aperture in the wall of the receptor cabinet, which is a small box forming a dark room for the cylinder which has a sheet of sensitized photo paper stretched around it. This cylinder moves about its axis and also end-wise on a threaded bearing (in exact synchronism with the transmitting cylinder), so that the reproduced picture is composed, as shown, of light and dark lines, these being sufficiently close together to give a fairly perfect picture.

Electricity is the only agent which will thaw frozen water pipes without digging them up. With the action of electricity the pipe can be easily thawed in a short time, the passage of current through the pipe heating it sufficiently to melt the ice.

Trolley Car Spreads Yuletide Cheer

To most of us the trolley car appears the same always, except, perhaps, during the holiday season when there is usually a change in the advertising cards that arrest our attention as we ride along.



A Trolley Car that Helped to Spread the Xmas Spirit in Toledo, Ohio. It Was Decorated Very Attractively and the Electric Flag at the Front "Waved" Realistically.

In the accompanying illustration we see how a Toledo, Ohio, trolley car was attractively decorated with an electrically illuminated sign, bearing the message "Merry Xmas—Do It Electrically"; also, a floating electrical flag on the front end of the car, the *tout ensemble* presenting a very pleasing as well as effective advertising attraction.

The purpose of this novel trolley car decoration was to help keep alive in the public mind the numerous meritorious features of doing things the electrical way. During "Electrical Week" to be held this December, electrical contractors and dealers thruout the country will preach the utility and economy of using electric current not only for lighting the home, but for doing the household wash, baking and cooking, washing dishes, *ad infinitum,* and not forgetting the electric curling iron heater to beautify my ladies' coiffure.

The American flag outlined in electric light bulbs and shown on the front of the trolley in the present illustration, is connected up with a special and cleverly designed flasher as it is termed technically, which causes bands of light to ripple across the flag and to thus give a very realistic effect of a flag waving in the breeze.

These electric flags are now being used very extensively thruout the country and as might be supposed, they are not to be employed in direct conjunction with any advertising matter.

It might seem a very excellent idea for the electric companies or even the trolley corporations (who wax fatter and richer each year on the public's hard-earned nickels) to carry out such a scheme as this, which, to say the least, is not prohibitive from the expense standpoint, besides being one that is bound to spread good cheer in one way or another, in much the same way as the appropriately decorated windows in our stores spread the Xmas spirit at Yuletide.

KILLING GERMS ELECTRICALLY.

A recently past Federal law requires a system of drinking water purification to be used on public carriers. An equipment using ultra violet rays from a mercury vacuum light has proved successful for this work and is being installed on many of the large lake passenger boats. A mercury tube is immersed in a tank or receiver in the water system so that all the water used is at one time or another exposed to the ultra violet rays from the tube.

Inasmuch as the mercury tubes require 220 volts, direct current, and the lake boats have but 115 volts available, motor-generator sets must be provided to operate on 115 volts and provide 220 volts for the lamps.

The operation is automatic; if the tubes burn out or the voltage fails, the electrically controlled intake valve of the tank is closed.

The Western Electric Company recently furnished six motor-generator sets for use on passenger boats. This is undoubtedly the first time a motor-generator set has been used to annihilate germs.

ELECTRIC TREATMENT FOR DIATHERMY OR FROZEN FEET.

The severe cold existing at the present time in the trenches of the European battlegrounds made it a necessity for the various fighting nations to employ some effective means for curing frost-bitten feet of the soldiers.

Naturally, a problem of this kind attracted the attention of scientists in various countries and especially those of the warring nations, all of which have developed different means for curing this ailment.

One of the earliest methods employed was that of placing the feet in hot water in which a given quantity of sodium chloride or common table salt was placed. This proved a partial success, inasmuch as the frost bite was relieved, even though only momentarily, but the need for a more effective cure was realized.

Therefore, the electrical method for this work, which has recently been developed at the Royal Baths, Horrogate, England, promises much relief to patients. The method employed is purely electrical and the photograph herewith illustrates an invalid being cured from the terrible affliction of frost bite by electric means.

As far as the constructional details of the apparatus used, there is very little information that can be obtained due to patent reasons. It is thought, however, that faradic electric currents are being employed.

The two plates which are bandaged under the feet of the invalid shown in the illustration are made of asbestos forms on which high resistance wire is wound. This is heated rhythmically by the electric current obtained from the machine on the right. The various knobs as seen on the cover control the intensity of the current supplied to the apparatus applied to the patient. The meter on the switch-board indicates the amount of current consumed.

Photo American Press Assoc.

Recently Perfected Electrical Method of Treating Frozen Feet of European Soldiers.

WIRELESS STATION AT FORT CONSTITUTION.

The Portsmouth, N.H., coast artillery district is now equipped with wireless telegraph. The station is located at Fort Constitution.

LORD KELVIN.
December Marks His 9th Death Anniversary.

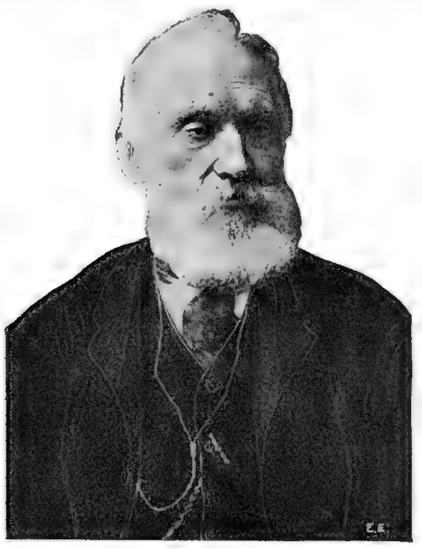
Born, June 26, 1824. Died Dec. 17, 1907.

William Thomson, who later became Lord Kelvin, was born in Belfast, Ireland, on June 26, 1824. At the age of ten he entered the University of Glasgow, in which his father held the chair of Mathematics. In 1841 he entered Cambridge University, from which he obtained his Bachelor's degree four years later. After studying a year in Paris under Regnault, the famous physicist, he was recalled by the University of Glasgow to take the Chair of Natural Philosophy, a title which included both physics and chemistry. He was knighted in 1866. He retained this post until his death.

One of his principal characteristics was brought out in connection with his work on the Mariner's compass. It had been the custom to use large, heavily magnetized needles to actuate the card and correction against the effects of nearby iron, which was a difficult matter. In 1874 Thomson was asked by the editor of a popular monthly to contribute an article on the compass. In preparing this his attention was brought strongly face to face with the deficiencies of the instrument then in vogue. And, when five years later a second article on this subject appeared, the author had redesigned the compass. His model, now in universal use, employs a light ring instead of the old card, and a number of small magnets fastened near the point of suspension.

In theoretical electricity, Sir William Thomson was the pioneer in the development of the theory of the ether. He laid down the hypothesis that all space is permeated by a weightless, perfectly elastic medium, thru which are transmitted all electric and magnetic forces. As opposed to the former theory of "action at a distance" this theory gave a means of applying mechanical analogies to electrical wave phenomena. Later, other scientists developed the equations which relate to all forms of wave motion, whether of sound, of water, or of electro-magnetic force.

One of Thomson's inventions was the *quadrant electro-meter,* an instrument for the measurement of very high potentials as generated by electrical machinery. He also developed the well-known *ampere-balance* and many other important inventions which are universally used.



Sir William Thomson, Better Known as Lord Kelvin, the Famous English Physicist Who Deduced Many of Our Present Electrical Theories.

Sir William Thomson represents a fine example of the scholarly ability to engage in widely different fields of endeavor. One of his earliest interests was in the subject of heat, and here he showed his insatiable desire to consider problems from the basic viewpoint of energy. There was no absolute scale temperature, and in a perfect engine the temperature is inversely proportional to the absolute internal temperature of the working agent. From this he deduced the location of the absolute zero, with reference to such a point as the temperature of ice. His values coincide very nearly with other values since determined in many different ways. His interest in geology led him to formulate a theory as to the age of the earth and to predict the probable amount of coal which might be available for future generations.

Lord Kelvin's life was strewn with honors and in 1892 he was made a Peer of the Realm, with the title of Baron Kelvin. His own sovereign conferred on him as well a Privy Councellor's degree, the Grand Cross of the Victorian order of Merit.

And above all, his lovable personality and warm heart brought him an army of friends; and when on December 7, 1907, the cables carried the news of his death, all scientists and those interested in science the world over mourned.

RAPID ELECTRIC DEVELOPMENT IN JAPAN.

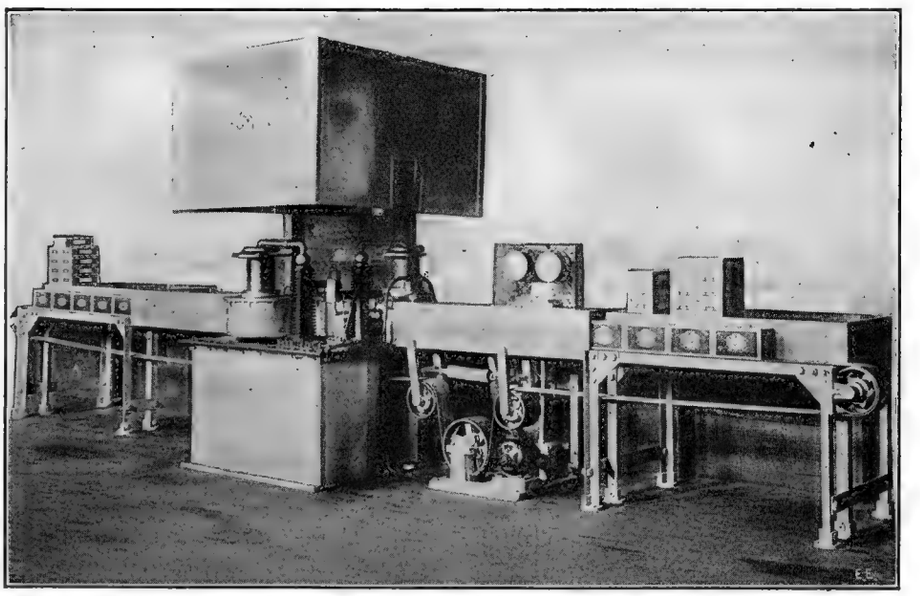
Electric service in Japan began in 1887 with a "home-made" 75 lamp dynamo installed at Nihonbashi. In 1907 a 15,000-K.W. hydro electric station transmitted power to Tokyo, 50 miles distant. At the end of 1914 a 14,000-K.W. hydro electric station transmitted power 140 miles at a pressure of 115,000 volts. This station brought the total capacity of all the generating stations in operation in Japan up to 609,000 K.W.

There are no less than 578 generating stations in Japan to-day, owned by nearly the same number of companies. More than 90 per cent are joint stock companies. The latest estimate of the available hydraulic power in Japan is 2,300,000 H.P. Japan is becoming an active market for electrical products of every kind.

The government of India will extend its wireless system until every army post has a station in the charge of a trained officer.

KILLING THE TOBACCO BEETLE WITH X-RAYS.

The tobacco manufacturer of to-day does not fear the damage occasioned by the tobacco worm. This pest has a variable period of incubation, covering an interval of a week or two, depending upon the temperature. Apparently sound cigars would be shipt from the factory only to be condemned, in a short while, by the dealer or the latter's customers. The unseen eggs hatched out their worms within the boxed cigars and as the insects desire to see the outer world, they break thru the tobacco of the cigar, thus producing a hole by their journey and consequently injuring the product.



By Means of This Extremely Powerful X-Ray Outfit It Is Now Possible to Kill the Tobacco Beetle in Boxed Cigars as They Travel Under the Rays at the Rate of 40,000 Cigars an Hour.

Several means have been tried to exterminate them, such as by electrocuting the eggs and passing high frequency currents thru the tobacco, thus trying to kill the newly hatched worms. But these methods have proven a total failure inasmuch as the beetle was not exterminated from the tobacco.

This problem has been handled in an entirely different manner by Franklin S. Smith, a well-known electrical engineer of Philadelphia, Pa. He employs the X-rays in his method of killing the eggs and worms of the tobacco beetle, and has been surprisingly successful in his task.

It has taken some years of research, however, to perfect the X-ray sterilizing machine as now employed in a number of factories in this country—notably at Tampa, Florida, and Harrisburg, Pa.

The apparatus herewith shown is the latest type of machine which has proven particularly efficient. The X-ray tubes are of the Coolidge heated-filament type and are encased in cast lead housings and enveloped by oil which fills the casings. The rays produced by the tubes issue forth thru a small window glazed with horn fiber, which is specially treated to prevent absorption of oil. The anodes of the bulbs are cooled by circulating water which is fed to them thru very small tubes. The Coolidge tubes are connected to high tension transformers as seen in the photo.

The boxed cigars are past under the rays by a moving conveyor which travels at the rate of nine inches a minute. This is driven by means of an electric motor as noted in the photo. Altho this machine seems simple in construction, yet 40,000 cigars are sterilized per hour.

DO YOU KNOW HOW TO TELEPHONE?

The majority of us use the telephone several times a day at least, but do we always give the party at the distant end of the line the benefit of the doubt? The *Telephone Review* mentions that a large terra cotta manufacturing company, who publish a bulletin for their employees, devote an entire page in a recent issue to calling attention to the proper method of telephoning. Experience justifies us in saying that some of our fellow-telephonists need to take this lesson to heart. The page is reproduced for their benefit:—

TELEPHONE

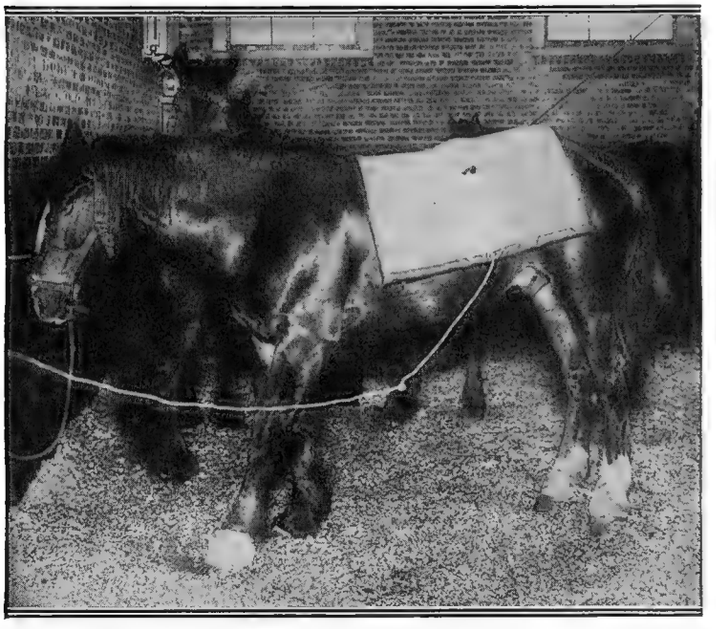
"In talking over the
telephone
face the transmitter
a few inches from the mouthpiece
and
speak clearly and distinctly."

Also when you try to signal central (including your house switch-board operator) to have a call transferred, move the hook up and down *slowly*—not rapidly!! If you move it too fast the line signal relay has not time to act.

EVEN THE HORSE HAS AN ELECTRIC HEATING PAD.

Even the horse enjoys the luxuries of the electrical current today. If Dobbin is sick or has a pain in his, perhaps her, abdominal region the twentieth century owner of horse-flesh calls not the old time doctor with his hot cloth panacea, but an up-to-date V.D. who applies, instead, an electric heating pad which fits over or around any part of the animal's body.

Sick horses are cared for in the electrical way at the Angell Memorial Hospital for Animals at Boston, Mass., and the horse here shown is being treated by the use of a specially designed heating pad. The pad, illustrated in service herewith, is 4 feet long and 3 feet wide; it has three heats and a maximum energy consumption of 600 watts. One side is rubber-covered, and it is connected to any convenient receptacle about the premises by a 25-foot flexible cord. Dr. F. H. Rowley, president of the Massachusetts Society for the Prevention of Cruelty to Animals, first used the pad in cases of "black water," a disease horses are subject to when overfed and under-exercised.



Treating "Old Dobbin" to an Electric Heat Bath by Means of an Electric Blanket which May Be Wrapt Snugly About Any Part of the Body.

CAN INFLAMMABLE OIL BE ELIMINATED FROM ELECTRICAL APPARATUS?

Refined petroleum or mineral oil has found application in the electrical industry in large quantities, notably in transformers and oil switches. The high insulating value of oil combined with its fluidity and suitable values of freezing point, boiling point and flash point and its lack of volatility have made it especially suitable for such purposes. In addition it serves as a lubricant of the contacts of immersed switches. Mineral oil has one drawback, however, and that is its inflammability, and a number of destructive fires can be attributed to the presence of this material in considerable quantities in power houses and substations, says *Electrical Review* editorially. It would seem as if there ought to be some material which will combine the desirable properties of mineral oil with freedom from inflammability, but as yet such a substance does not seem to be available.

That the problem is not one without a hope of solution is indicated by some tests recently made in Germany. The material experimented with was carbon tetrachloride. This liquid is non-inflammable and non-explosive. It has a boiling point of 78 degrees centigrade and is decomposed at a temperature of about 290 degrees. Its specific gravity is about 1.6. It is colorless and has an agreeable aromatic odor. It is a good insulator and its dielectric strength is not much different from that of mineral oil. While it is possible to use this substance as a substitute for oil in electrical apparatus, it has two disadvantages. One is its volatility and the other is that it acts chemically upon copper, rubber and certain other materials. However, aluminum, mica and fiber do not seem to be affected by it. To overcome its volatility, experiments were made by covering it with a layer of glycerine, but this did not prove entirely satisfactory.

The German investigator, Mr. M. Vogelsang, suggested that a mixture of oil and carbon tetrachloride, which would combine somewhat the properties of the two, might be useful. A mixture of three parts of the former with one of the latter is not very inflammable and volatilizes very slowly, so that it might prove useful.

AN ELECTRICAL FLOAT MADE OF FLOWERS.

The accompanying illustration shows a particularly attractive float recently drawn thru the streets of Youngstown, Ohio, in an industrial parade. This gigantic replica of an electric motor was formed of flowers appropriately mounted on a wooden skeleton work. The structure was carried on a concealed electric-vehicle body and proved to be one of the leading features of the parade. The model was complete even to the screweye at the top and the pulley on the shaft. This is a good suggestion for electrical contractors all over the country, as many opportunities will arise during the coming *America's Electrical Week* when such floats can be advantageously used to advertise electric service.

An Unusual Flower-decorated Float Built to Resemble a Huge Electric Motor, which Appeared in a Parade in Youngstown, Ohio.

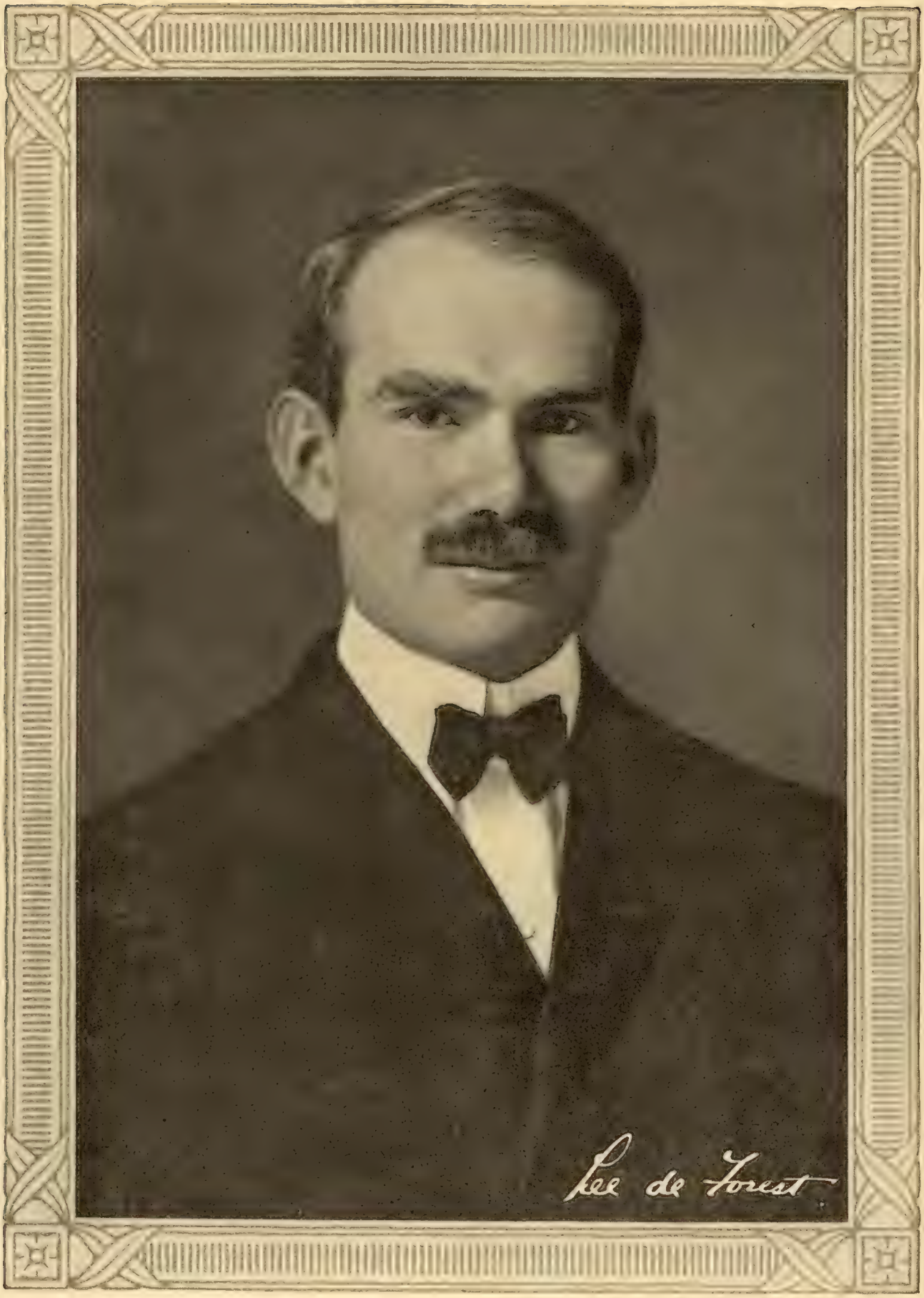
Some years ago an Eastern electrical contractor in a small city evolved a clever idea for an electrical parade float. This design made use of an electrical sign of quite large proportions, the low voltage bulbs of which were winked on and off by a flasher, the current being supplied by the storage cells removed temporarily from an electric vehicle.—*Photo courtesy Electrical World.*

LECTURES ON ELECTRICAL TOPICS TO BE GIVEN IN NEW YORK CITY.

A number of important courses of free public lectures on electrical subjects will be given in New York City during the school year, under the direction of the Department of Education.

Dr. Ernest R. Von Nardroff, of Stuyvesant High School, will deliver twelve lectures on "Electricity, Atoms and the Ether" at the American Museum of Natural History, Manhattan, on successive Saturday evenings, which began October seventh. The second of twelve Monday evening lectures by W. Wallace Kerr of the Hebrew Technical Institute, on "Principles and Practices of Electrical Engineering," was given October ninth, at Public School 62, Manhattan. On October tenth Charles L. Harrington began a course of six lectures, given on alternate Tuesday evenings, on "Electricity and Magnetism," at Public School 36, the Bronx.

In Brooklyn, Frederick W. Huntington, of Erasmus Hall High School, started a course of lectures on "Electricity and Magnetism," at Public School 159, on October sixteenth and which will be given on successive alternate Mondays. On alternate Mondays he will repeat the lecture in Queens, at Public School 34.


Lee de Forest

Dr. Lee De Forest—This Month's Supplement

DR. LEE DE FOREST, the well-known radio engineer and scientist, who is possibly best known to our readers and others through his research work in developing the Audion detector and amplifier, is a man of mature years and gives one the impression of being a profound thinker; and those who know him well can verify this fact. It is said of him that even when eating his meals he is inclined to constantly scheme out some new wireless circuit or calculation which has been uppermost in his mind. He is a rapid thinker and personifies great dynamic energy. A slide-rule and notebook are his constant companions and he trusts no intricate calculations or philosophical problems to his assistants, but always makes his own deductions.

Dr. de Forest's general bearing and appearance is that of the born scientist; in fact, one could hardly picture this indefatigable worker in any other rôle. Like most great men he does not narrow himself down to the point where his philosophical studies and researches occupy his mind all of the time. He is broad-minded, widely read and a great lover of music and one of his principal researches in later years has been the development of musical Audion bulbs; and he has had a good measure of success with them.

So enthusiastic was Dr. de Forest in his early wireless research days when he first came to New York, that he carried on his first courtship *via wireless*. At the time, this story was one of the most popular in the daily press; and the invention really worked very well indeed; so well, in fact, that Dr. de Forest concluded his experiments in this direction by marrying the girl! The *modus operandi* of engineering this startling experiment involved the installation of a powerful wireless transmitting and receiving station at Dr. de Forest's laboratory, also one at his living apartments and a third at the apartment of his sweetheart.

The month of August in the year 1873, saw the birth of Dr. Lee de Forest, in the then small town of Council Bluffs, Iowa. His parents at an early date moved to Alabama, and it was here in the palmy Southland that the subject of our supplement spent his boyhood days. He was educated in the private schools and late attended the Mt. Vernon school for boys in Massachusetts, at which Academy he prepared for entrance to Yale University, as by this time he had quite firmly decided upon a scientific career. And so as a young man, we find him studiously engaged at the Sheffield Scientific School at Yale with the degree of "Mechanical Engineer" as his goal.

He graduated from this institution in 1896 and after pursuing two years of post-graduate work, specializing in mathematics and physics, he received the degree of Doctor of Philosophy. For his Doctor's *thesis* he prepared a paper entitled "The Reflection of Hertzian Waves at the End of Parallel Wires," which was received very favorably and with considerable commendation by his professors and fellow students.

After leaving the University he engaged with the Western Electric Company, at Chicago, in their experimental telephone laboratory. In 1900 he began active work in wireless telegraphy, first in Milwaukee, then at the Armour Institute of Technology, in Chicago, where he began to develop the first form of electrolytic wireless detector. In 1901 he came to New York with this receiver to undertake the reporting of the International Yacht Race of that summer off Sandy Hook. During this work the Ruhmkorff spark coil was used as a transmitter, but its many disadvantages prompted Dr. de Forest to design an alternating current transmitter. He never used the Ruhmkorff coil after that first trial. The alternating current generator and transmitter are now universally used in all modern wireless transmitting sets.

Dr. de Forest was also the first to use the telephone receiver with an auto-restoring detector, in place of the relay and Morse ink recorder. This one simplification has perhaps done more to commercialize wireless telegraphy than any other single factor.

Due to the simplification of transmitter and receiver which he introduced, the business of his company, The American de Forest Wireless Telegraph Company, began to increase by leaps and bounds so that in 1906, there were over fifty vessels equipt with the de Forest system and some thirty shore stations. The United States Government at that time purchased little except de Forest apparatus.

Dr. de Forest designed and installed the first five high-power radio stations in this country for the United States Navy at Key West, Pensacola, Guantanamo, Colon and Porto Rico. During this period he applied for, and took out, a large number of radio apparatus patents, among the most important being those covering the *horizontal receiving antenna;* the *directive antenna or localizer* and the *duplex method of sending and receiving* by means of two separate stations, one for sending and one for receiving, connected by a telegraph wire (this arrangement is used at most of the transoceanic wireless stations to-day although Dr. de Forest has never been given credit for his invention). Also in the Russian-Japanese War the de Forest radio apparatus proved extremely valuable.

In 1906 he devoted his entire energy to the problem of *wireless telephony.* His first invention of importance was the use of the microphone in the earth connection, where it has been used in practically all wireless telephone transmitters ever since. He developed the water jet arc which has subsequently been featured by the Italian, Majorana.

Most important of all the de Forest inventions is, of course, the Audion group. Beginning to work on the principle of a heated gas detector in 1900, he demonstrated the practicability of this type. Coincidently with the description of the Fleming valve Dr. de Forest brought out the first Audion element mounted in a vacuum

(Continued on page 611)

WITH THE JANUARY ISSUE

we will present another

SUPPLEMENT

of a famous electrical inventor. This is the third of a series promised to our readers.

These supplements are printed on fine art paper, ready for framing. They are invaluable to adorn your den, your wireless station, or your laboratory.

Order your copy now, to make sure you will get it.

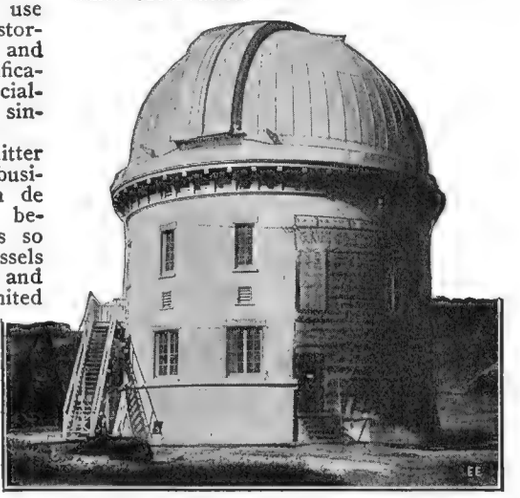
METAL DOME CATCHES RADIO TIME SIGNALS.

By George V. Tudhope

THE great telescope which was on exhibition in the Liberal Arts Building at the Panama-Pacific International Exposition has been installed in the City of Oakland's new observatory and is to be used, primarily, as a branch of the city's school work.

This telescope is the eighth in size and the fifth in power in the United States, and is the largest known to have been erected by any municipality for public school purposes. It is twenty-eight feet in length, weighs ten tons and carries a Jena glass objective lens, twenty inches in diameter. When the telescope is pointed toward the zenith, the object glass or upper end of the tube is thirty-eight feet above the floor. The observatory is located on one of the foothills of the Coast Range in California.

In order to facilitate the technical work of determining the exact latitude and longitude of the observatory, which must be known as a base for all future observations the author was requested to provide radio apparatus so that the time signals from the United States radio station at Mare Island, some twenty-five miles distant, could be received and used as an aid in these and other observations.



Wireless Time Signals Are Readily Picked Up at This California Observatory by Using the Metal Roof as an Antenna.

The large dome of the observatory is constructed of sheet metal and made to revolve upon an iron track, about forty-five feet above the ground by flexible steel cables driven by an electric motor on the first floor. Having noted that the dome, motor and steel cables were sufficiently insulated from the ground by the plaster boarded frame walls and wooden floors, and not wishing to mar the scenic beauty of the observatory and its surroundings by the erection of a radio mast, the metal dome of the observatory was used as the antenna. An ordinary, two-slide tuning coil with silicon detector, small condenser and two thousand ohm receivers, were connected in the regular way to the steel cables leading in from the dome and to a one-inch galvanized iron pipe driven about eight feet into the ground, with the result that the radio time signals came in sufficiently clear and loud enough to be heard two feet from the receiver.

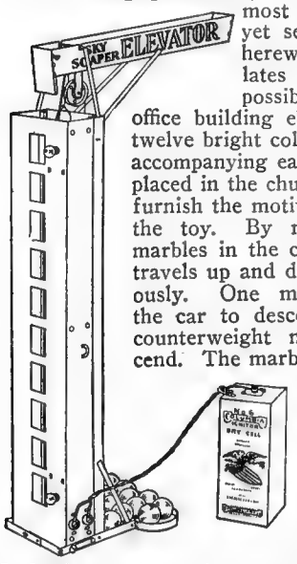
Professor Charles Burckhalter, Director of the Observatory, is an ardent advocate of radio receiving sets as permanent fixtures in all places where astronomical observations are made.

An electric oven in Toronto, Canada, turns out nearly 3,000 loaves of bread a day.

Electrical Xmas Suggestions

ELECTRIC ELEVATOR THE LATEST TOY.

We have an ever growing list of electric toys with which to delight the hearts of the rising generation, but one of the most novel ones yet seen is shown herewith. It simulates as nearly as possible a detached office building elevator. The twelve bright colored marbles accompanying each toy, when placed in the chute at the top, furnish the motive power for the toy. By replacing the marbles in the chute, the car travels up and down continuously. One marble causes the car to descend, and the counterweight makes it ascend. The marbles discharge at the bottom as shown.



This novel toy, is equipt with miniature tungsten lamps in red and white, which flash alternately as the car runs down and up. The lamps can be operated by any standard one-cell dry battery.

This toy, with its novel mechanical movement, the wiring, electrical switches, lamps, etc., is interesting and instructive to any child. The tower is lithographed in colors, the car showing the elevator operator in front and the passengers at the rear.

A 90-WATT "BABY" ELECTRIC IRON.

One of the latest electric novelties is the electric "Baby" Iron, which is less than one-half as large as the ordinary size household iron. It is light, compact and extremely economical.

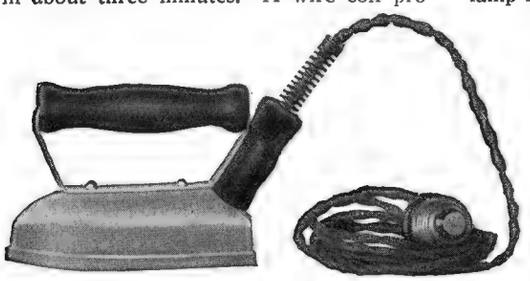
Among other things it will press handkerchiefs, fine linen, laces, lingerie, baby clothes, cuffs, sleeves, fancy collars, ruffles, and light ladies' wear of all kinds.

Its low price and practical utility make it just the thing to give to little girls who wish to help mother with the family ironing.

The "Baby" is strongly built to withstand rough handling—it is furnished with six feet of maroon cord and a plug suitable for attaching to any standard lamp socket.

The current consumption is only 90 watts, about one-sixth of what the standard household size iron consumes. It operates on 100 to 130 volts.

This little iron heats up readily for work in about three minutes. A wire coil protected attachment plug on the iron, enables one to disconnect the iron from the cord while working. It weighs but one pound.



A New 90 Watt "Baby" Electric Sad Iron. A Gift of Lasting Appreciation.

CHANGE YOUR OIL LAMP TO ELECTRIC.

In nearly every home are stored away old oil lamps—relics of the dark ages of lighting. Every oil lamp can now be transformed into an electric lamp by attaching to the burner the new electric light attachment for oil lamps here shown.

This handy, inexpensive device consists of a pull chain socket with round base which fits any flat wick or center draft burner. It is equipt with flexible cord and attachment plug for connecting with any lamp socket or base receptacle.

No tools or skill are required in order to convert the oil lamp into an attractive electric one, and the attachment shown is supplied in any finish to harmonize with the lamp shade used. Many people have valuable oil lamps stored away which can now be drest up in modern style at small cost and serve not only as ornamental objects but useful ones as well. This applies particularly to the pedestal style piano and parlor lamp of a generation ago, with its graceful base and silken shade redolent of the days of our grandfathers, when the drawing-room was a work of art—not a repository for "canned" music and speech reproducing machines only.

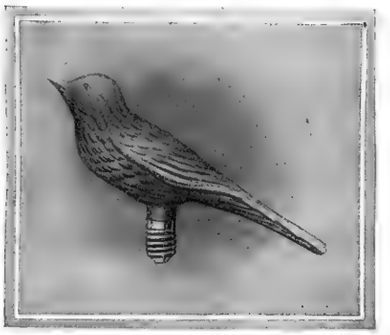
Those Who Have Valuable Oil Lamps Will Appreciate This Electric Light Attachment, Which Brings Them Once Again Up-to-date.

BIRD XMAS TREE LAMPS.

A novelty in Christmas tree decorations is a transparent bird with a tiny electric lamp inside it. The bird shown is half the actual size. These are made for 3½-volt battery Christmas tree outfit only, with tungsten filament and miniature base.

They are made of an unbreakable transparent composition and can stand careless handling. The birds are ingeniously moulded and colored representing parrots, some with green head and tail, and white body; others red, etc. Canaries in yellow, robins, doves and others. These very attractive decorative novelties are particularly well made and present an extremely realistic appearance.

No well decorated Xmas tree is complete now without a dozen or so of these songless, yet handsome illuminated birds. The small receptacles accommodating these artistic lamps are easily fastened to the limbs of the tree by a piece of wire. And when all is said and done there is no danger of fire as when candles are utilized.



A New Transparent Bird Lamp for Xmas Tree Decoration.

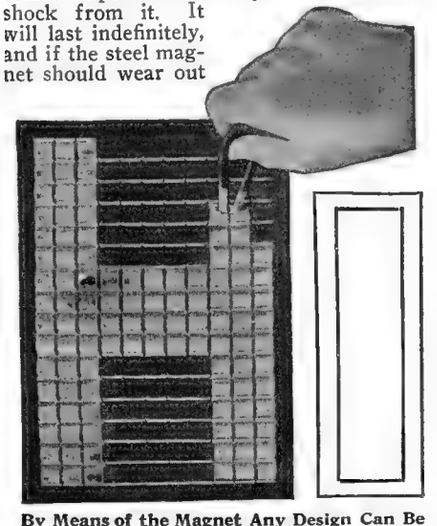
A MAGNETIC ALPHABET TOY FOR THE KIDDIES.

The novel magnetic alphabet toy illustrated herewith consists of a sheet metal plate, beautifully enameled, and is reversible—the two sides being in different colors. The plate is perforated with small slots and in each slot there is suspended a semi-circle of silvered sheet metal, which slides freely through the slot to either side of the plate, but is so made that it cannot possibly drop out.

Upon drawing the magnet downward over the face of the plate, the semi-circles of silvered metal are drawn through the plate from the other side to form any letter, figure or design wisht. To *erase* the letters or designs thus formed, the plate is tilted backward to a horizontal position. The manner in which these silvered pieces follow the magnet is a source of never-ending delight.

For kindergarten or educational purposes this novelty would seem to impress upon the mind as in no other way, the form of the different letters of the alphabet, and figures and designs of all kinds. It may also be used as a counter. It will be readily seen that numerous games may be played on it, such as Tic-Tac-Toe, etc.

The device is strongly made and is practically fool-proof. Also there are no batteries used in operating it, so that it becomes impossible for anyone to receive a shock from it. It will last indefinitely, and if the steel magnet should wear out it may be replaced by a new one at small cost.



By Means of the Magnet Any Design Can Be Formed. Very Instructive.

WHY TELEGRAPHERS RISE TO RESPONSIBLE POSITIONS.

The habit that many telegraph operators have of climbing and reaching the top of the ladder was recently the subject of an editorial article in the New York *Sun*. The article is headed "They That Desert the Key," and we read as follows:

"Why do telegraph operators become railroad presidents? The question forces itself upon the mind through the reiteration of facts. As often as we read that the winds will be moderate and southerly, and that Villa is dead, just so often do we read that the new head of the so and so railroad began his business career as a sender of Morse messages. Bernet of the Nickel Plate, Calvin of the Union Pacific, Levey of the Western Pacific, these are three of this summer's crop of presidents who went, as a railroad poet might say, from the sounder to the scepter. The list of distinguished railroad presidents of these and older days is full of operators: Van Horne of the Canadian Pacific, Hughitt of the Northwestern, Newman and Brown of the New York Central, McCrea of the Pennsylvania, Hayes of the Grand Trunk, Tuttle and Todd of certain New England lines.

"How telegraph operators become railroad presidents would be easy to tell. Your operator hears everything, knows everything, does everything. He is aware how far a division superintendent may go in spirited debate, by wire, with the general manager. He comes to know upon what days the chief dispatcher is afflicted with tantrums. He flags the night express on the brink of the washout, supplies the jolly brakeman from his own paper of fine cut, chops Mrs. Jones's telegram to ten words, fills the station stove, figures transmissisippi freight rates, sells excursion tickets and has an eye for the ladies. On Sunday afternoons, between the 2:46 and the 5:58, he plays first base on the town nine. Thus he acquires a rounded life, with the wisdom of near and far. Presently the boss of the division takes him into his own office and his doom is written. Nothing but the scythe or the bottle can prevent him from becoming president of the road.

"Why he lets himself be hurried on down the path puzzles us. He wears better clothes as he goes on, but is obliged to pinch the fine cut surreptitiously. He joins a country club, but his old place in baseball is lost to him. The brakeman calls him Mister instead of Joe. Nobody flags the night express and he spends a week with a coroner's jury. Coming to the presidency, he finds that the rates east and west of Clinton, Iowa, instead of being horribly complicated, are merely horribly small. The eye that once was for the ladies is now cast languishingly at the Interstate Commerce Commission. He is 55, practically fat, and plays golf. They all play golf, these presidents who were brass-pounders. It seems to be part of the doom.

"All in all, the operator who falls to the position of president reminds one of some doughty adventurer who has been lured away from adventure. Time was for him. As he sits in his mahogany inglenook, holding out his road's empty bowl to the Commerce Commission and begging for just a little more freight rate gruel, one prefers not to remember the lad who was so free and lithe and gay. Yes, 'tis a horrible fate, but lead us on, lead us on."

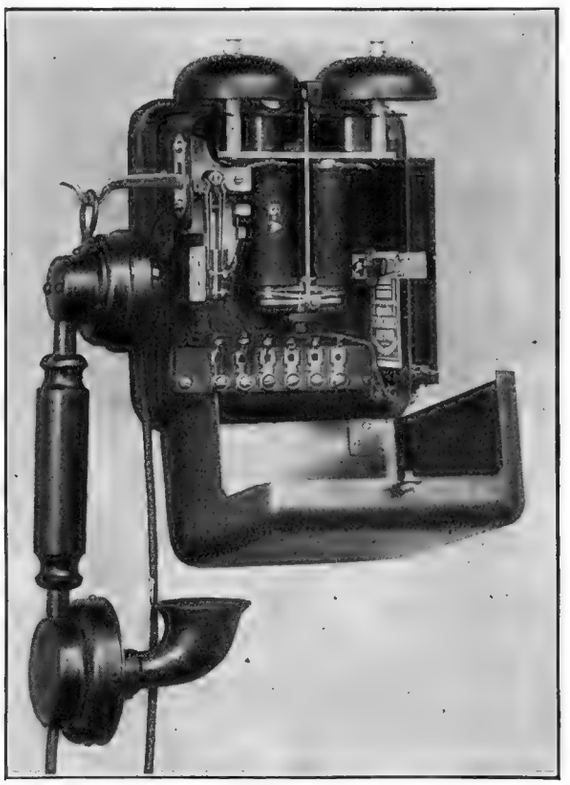
A TELEPHONE THAT FITS YOUR HAND.

While the standard form of wall telephone serves its purposes well there are many occasions where a handier instrument appeals; that takes up but little space. Such a 'phone is pictured here.

This style of instrument is suitable for either office or residence installations. It can be mounted on the side of the business man's desk or on an adjacent wall within convenient reaching distance. It should be popular in the home with persons who prefer to *sit down and talk*.

In factories, mills and machine shops this instrument gives greater satisfaction because no vibrations caused by running machinery can affect the operation of the transmitter while the instrument is being used. Other types of telephones with rigidly mounted transmitters pick up much foreign *noise* when subjected to such local conditions.

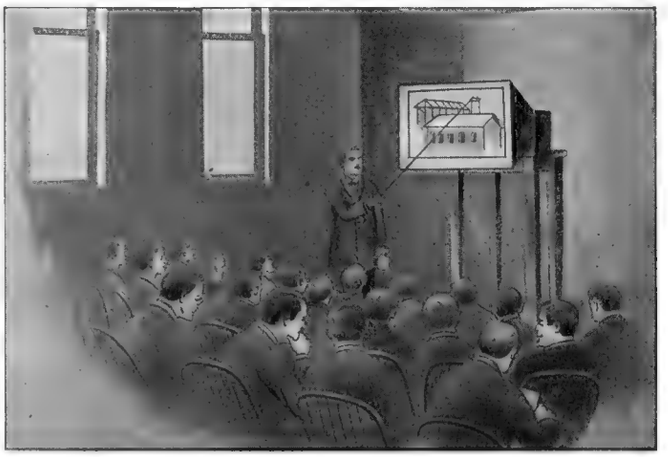
The telephone is equipped with a transmitter and receiver of standard size, and its normal transmission efficiency is claimed by the makers to equal or exceed all others. The subscriber naturally speaks directly into the mouthpiece and operates the transmitter at its full power.



One of the Latest Designs of Telephone Instruments, Enabling You to Sit Down and Talk, as It May Be Removed From the Hook.

TEACHING WITH THE ELECTRIC STEREOMOTOGRAPH.

Most persons are quite familiar with the method of teaching some subjects with the aid of a text-book, combined with a more or less clear explanation by the instructor. The student is also familiar with the long number of hours that he must spend before he can thoroughly grasp a subject like geography, botany or zoology. The reason for this is that he is not shown the exact things which he has read in the text; consequently he is forced to read and re-read the same paragraph in the book, before he can begin to picture the object which he has studied. This, however, is not the case with the teaching of chemistry, physics and allied engineering subjects, as in these it is required by every school that a certain amount of experimental work must be conducted, thus causing the student to master the subject fully by actually *seeing* the thing which he has been studying.



The Stereomotograph—An Instrument Devised to Aid the Teaching of Difficult Subjects by Projecting on a Screen Actual Views of the Object Discussed.

Of course, this cannot be done with every subject, but there are other means whereby studying can be made more interesting. One promising method has been suggested, involving the use of the motion picture machine installed in the class room to project the lesson in picture form, before the students. This method has often failed on account of the difficulty of obtaining the required films. A second method is to use a projecting machine which employs lantern slides.

The first machine which has proved most suitable for this class of work is the *Stereomotograph*, which is a special form of stereopticon projector. The only difference between the latter and the first instrument is that the improved model has a special slide magazine, which holds 52 slides of the ordinary lantern type, which may be projected in consecutive rotation at the rate of about four slides per minute, or may be controlled by means of a push button at the end of an electric cord at any distance from the machine. The pictures projected by this device are big enough to be seen in a large auditorium, and our illustration shows one in use in a fairly large class room. The instructor can speak on the various points of his topic with great ease.

The Stereomotograph is not only adapted to educational work but has been used with equal success in advertising, and it will undoubtedly be put to many other uses which require a projecting machine of this type.—*Photo courtesy of Charles Beseler Co.*

How the "Wireless Wiz" Turned Evangelist—A Xmas Story

By Thomas W. Benson

DID it ever occur to you that the "Wiz" was a psychologist? No? Neither did it to me until this Christmas. He is usually so exorbitantly optimistic that one wonders how in the name of Buddha's sandals he ever manages to survive the Yuletide season; he is fairly bubbling over with good nature thruout the year so much that at Christmas he usually seethes with happiness and can't stand anyone who is gloomy.

Just one minute, Salvador, and you will see what all this has to do with the story pretty soon.

However, he usually wastes enough time to find out what is the matter with the gloom-bearer, and usually finds a simple remedy. For instance, look at the ease with which he made a rip-roaring, regular optimist out of "Polar" Nolan. Now Jim Nolan was the worst kind of a joy killer—that's why we dubbed him "Polar." He was as nice and sociable as a hungry polar bear in March. The "Wiz" just went and —wait a minute, Ignatz, I'm getting ahead of myself again.

It all came about this way. One night the three of us were up in the "Wizard's" "lab"—"Polar," the "Wiz" and I. The only thing Nolan was a bear on was his *code*. That boy could pound out the prettiest music on a key that ever disturbed the ether. And speed, why boys, he had it to burn; just for fun he would shoot his wave length above the limit and when the "Ham" at the "yard" balled him out, he would come back with some of his fast fox-trot stuff and have the poor baby hanging on to the wireless echoes to get the drift of his line of etheric spark music.

Anyway that night "Polar" was running along with his local throttle wide open, smashing conventions and making a general wreck of all the beauty in the world. He was almost proving that everything was hypocrisy and bluff; all the good in the world having petered out some centuries ago, and our modern conventions were merely parodies on things as they were. It was the week before Christmas, and naturally the gift argument came up to the tune of some real planning.

"Gifts," he sneered, "gifts nothing. Merely a sort of here is a present, see-if-you-can-go-me-one-better sort of a deal, with the odds that you will get stung in the end! Oh, what a beautiful thought! Not! It reminds one of the old horse traders brought up to date and dressed in a red suit with snow balls thrown at the more prominent parts of the costume."

"Avast there, philosopher," broke in the "Wiz," "how would you like me to make you take back those words?" he asked. "Not that it really makes much difference to me, but why try to stifle the good thoughts that can't help but run in your mind at this time of the year," he added.

"Can't be done," boasted Nolan as he rose to go. "If I don't see you during the week be sure to hang up your stocking for Kris-Kringle," was his parting shot.

"Yes, I'm going to call his bluff," breathed the "Wiz" in answer to my mental telepathic question as he returned from seeing the caller to the door. He picked up a new *electron relay* bulb that he had recently ordered and was toying with it. As he sat there studying it a smile spread across his features, and as if talking to himself and weighing every word he whispered what sounded like a prophecy. "They used electrons to talk to Hawaii; they used them to talk to 'Frisco and now I'm going to use them to talk to a man's soul."

The mystical wonder of it kept me silent; I knew he was not bluffing, was perfectly sane, but to talk to a person's inner being was a little, yes, just a little beyond me.

"Yes, it does sound ridiculous," he broke in on my reveries. "Ever hear of what is known as the *psychological moment?* Well, at that time it is possible to play with a person's passions and thoughts to an unbelievable extent. All you have to do is to bring 'Polar' over here late Christmas Eve and I'll show you how it all works out," he instructed me, and he began testing out his burglar alarm system, which was a polite method of handing me my hat and coat, without the effort usually accompanying such actions. I'll tell you about that alarm system some time; no, Alphonse, it has nothing to do with this story.

Christmas week is always a busy time and I gave very little thought to the coming experiment of the "Wiz." Caught him on the ether one night and he informed me all was O.K. and that ten o'clock would be about the right time to drop in. I never had cultivated Nolan to any great extent and had a little difficulty in getting him to accompany me, but perseverance will accomplish most anything. I rounded him up finally and we proceeded to the Wizard's domicile.

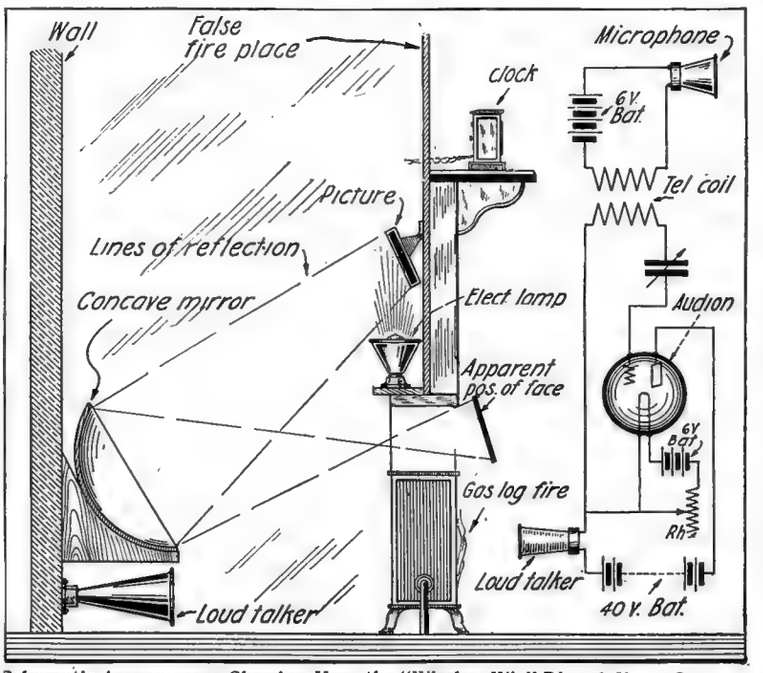
". . . . The 'Wiz' Switched Off the Lights and the Three of Us Had Settled Down Behind a Like Number of Thoroly Healthy 'Jimmy Pipes.' . . . . The Music Had but Half Finished when I Almost Sprang from My Chair in Alarm, for There, Above the Flickering Flames, Slowly Appeared the Face of HIM who Died that the World Might Be Saved."

The "Wiz" greeted us cheerily and led us into the room where he had arranged the usual innocent looking Christmas tree. He switched on the lights to give us a peep at the arrangement, which was up to his regular standard. He had succeeded in getting a very attractive effect in a novel manner. Instead of the tree standing upright it was apparently broken off about one foot from the bottom and leaned against the side of the room. It also seemed as if part of the branches had dropped down and away from the trunk of the tree proper, thus revealing the gifts displayed.

"I'll show you the main idea of it," he said, switching off all the lights. In the dark we heard him fixing something about the tree for the rustling of the boughs was plainly heard as well as several faint clicks.

In a moment he closed a switch and the room was faintly illuminated; just sufficient for us to make out the objects therein very indistinctly. And how uninteresting they seemed. The tree was now standing upright, no trimmings being plainly seen; apparently it was the forlorn object it purported to be.

"Now, watch!" directed the "Wiz." Suddenly a stroke of lightning appeared to leap from one corner of the room—a flash appeared at the base of the tree which began to fall over as if struck by lightning. Just as it struck the other wall the room was brilliantly illuminated and the gifts were suddenly displayed as if by magic in the little bower under the tree while the other boughs flew out with their many colored trimmings, glittering and gleaming under the electric light.



Schematic Arrangement Showing How the "Wireless Wiz" Rigged Up a Concave Mirror to Catch the Reflected Image of the Photograph and to Throw It Out Into the Flames Just in Front of the Open Fire-place.

"It's really very simple," laughed the "Wiz" as he realized our apparent amazement. "For the lightning bolt I fasten a length of twisted wire from one corner of the ceiling to the base of the tree. The insulation is scraped from the top of the wires so as to bare the conductors but not short-circuiting them. A small carbon ring is released by a magnet and sliding down the wires, makes connections with them, thus forming a spasmodic arc that travels rapidly the whole length of the wire.

"On its striking the base of the tree, the traveling ring swings against a contact that ignites a charge of smokeless powder and by means of a magnetic release the twisted wires are detached from the tree base and swing back against the wall, thus being unnoticed when the room is lit up.

"The boughs of the tree are bound together by fine wire, which also holds up a compartment for the gifts. This compartment is made from a shallow box covered with boughs from a tree and hinged so that it can be swung up in back of the tree proper. Thus the box is hardly noticeable in the dim light, but as the tree is pulled over by the action of a weight as soon as the powder explodes the fine wire binding the boughs is released and they swing out and at the same time the box drops down, displaying the array of presents."

"The idea is clever," complimented Polar, "but don't you think you could have made better use of the valuable time spent

(*Continued on page 615*)

SIMPLIFIED SPELLING ADOPTED BY THE "E.E."

Beginning with the present number we will use *Simplified Spelling* as given in the publication on this subject issued by the United States Government Printing Office and as recommended by the "Simplified Spelling Board" during Ex-President Roosevelt's Administration.

Simplified spelling, as recommended by executive order of Ex-President Roosevelt for use by all Government departments, incorporates a list of 300 words.

Contrary to general opinion, it is not at all difficult to memorize the recommendations of the Simplified Spelling Board, as will be apparent from the following examples:

Instead of thoroughly, this word is spelled t-h-o-r-o-l-y; instead of through, we have *thru;* instead of thorough—*thoro;* in place of though—*tho;* in lieu of stopped, we find *stopt;* instead of adze, we use *adz;* instead of dashed—*dasht,* etc., etc.

Copies of the bulletin on Simplified Spelling containing the recommendations of the Simplified Spelling Board and also the authorities constituting the personnel of this Board, as well as their reasons for making these recommendations, may be obtained from the Government Printing Office, Washington, D.C.

PLAN TO FLOOD-LIGHT STATUE OF LIBERTY ON DECEMBER 1ST.

The Statue of Liberty, gift by the Republic of France to the United States, will be illuminated for the first time with its new permanent flood-lighting on the night of December first, according to a program just announced by *The Society for Electrical Development.*

The statue belongs to the nation and not to any city in it, and its flood-lighting on the eve of *America's Electrical Week* (December 2-9, 1916) most appropriately inaugurates the national electrical celebration starting December second. It is proposed to consecrate it with the President, possibly, and the Atlantic Fleet, prominent civic and governmental officials present at a notable program of dedication.

Thru the activities of the Society, in co-operation with the *New York "World"* and with leading Government officials and electrical engineers, plans have been made to lay a cable from the New Jersey shore to Bedloe's Island, which will carry current for the illumination. This will provide all Bedloe's Island, where the statue is located, with central station service instead of the isolated plant as was originally proposed.

This installation will endure as a national exhibit of central station service and, in a picturesque way, be an inspiration for flood-lighting civic buildings, arches, statuary, et cetera, thruout the cities of America.

In furthering this project, the Society's general manager, J. M. Wakeman, addressed letters to all the 268 *America's Electrical Week* committees, earnestly requesting each committee to set aside Saturday, October twenty-eighth, as "Liberty Day." This date was the thirtieth birthday of the Goddess of Liberty, and was the last official day upon which donations were received to flood-light the statue. Electrical engineers began the installation directly after.

The lighting of the statue under such distinguished auspices was heralded by the press across the country, and the electrical industry was congratulated for its part in thus assembling the final portion of the fund to permanently flood-light the statue.

CONGRESS TO VOTE ON ELECTRIC SCORE-BOARD.

By installing an electrical score board Congress expects to reduce the average time occupied in calling the roll from 40 minutes to 34 seconds. A bill has been introduced to electrify the roll call.

A Congressman with a head for mathematics estimated that fifty-six days were spent calling the roll during the last session of Congress. He calculates that the House would save one month out of every year, besides a saving of $50,000 a year in light, heat and telegraph service.

The device is an invention of a Milwaukee man and, when installed, will consist of a big board upon which each Congressman's name will appear. Opposite the name will be a red and white bulb. At each Congressman's elbow there will be two buttons which may only be pressed after the individual board has been opened by the Congressman's key.

The machine automatically adds the vote and shows the result. It will require about seventy miles of copper wire. Those favoring the device say it will last a couple of centuries and that it will splendidly save its own cost.

ELECTRIC SIRENS AID TO OFFICE BOY.

In far-away Hawaii there is an installation of twenty electrically operated sirens which are distributed thruout an extensive sugar mill. These sirens are sounded thru a push button. By a system of signals—a different one for each department head—a man is told instantly, in the noisiest part of the plant, that he is wanted on the telephone. It has proved a great saver of office boy trips and is recommended for widely scattered plants.

Ups and Downs of a Telegraph Line

By Thomas Reed

IN these days of wireless I suppose the old wire-telegraph is no longer good form in Bugdom. I don't blame you, Bugs; not much attraction in a line a few hundred yards long when you can have the whole world, with a few oceans thrown in for good measure, to play over!

Lucky Bugs! You don't have to ring a grouchy neighbor's bell, look him in his glaring eye while you beseech him in a shaking voice, "Please, mister, can we put just a little bit of a wire up on your house for our telegraph?* It won't hurt it a mite, mister," and be handed back a growling "No!" and a slam of the door in your face.

No, sir, you just snap off a spark up in your attic and it shoots out right through and through the grouchy neighbor's house, not to speak of himself and his Ford car, and everything else he owns, and he can't help himself.

In my day the grouchy neighbor was an important factor because the wire-telegraph was all we had. It was all anybody had for that matter. I've told you something about our heartbreaking struggles to make sounders and keys. When we had them at last, our next ambition was for a line-wire; but this was a problem that gave us pause, for it meant a cold, deliberate expenditure of money; no help from the workshop at all. If it had required a few strips of skin from our backs, the prospect would have been brighter.

**That so! Mr. Reed probably never approached a cantankerous fish-eyed, apartment-house landoverlord with the modest request of sticking a 10-foot aerial mast on top of his roof! The city Radio Bug hasn't always a cinch of it either!!—Editor.*

We made a minute estimate of the cost, with the aid of the arithmetic. The result was depressingly accurate, and confirmed us in our opinion of that pestiferous study as a kill-joy pure and simple. Why arithmetic should be piled on top of our other inflictions we never could tell. We had a theory that once upon a time there was a boy who liked to go to school—doted on it, pined for it—so, to cure him of pining, they invented arithmetic and after that he got healthy again and hated school as is natural. Arithmetic must have been kept on the list for other reasons in our case. Anyhow, it was just like that mean, close-fisted science to take delight in showing us exactly how hopeless our wire-proposition was for, in spite of all the skimping we could do on the size of wire and quality of insulators the cost insisted on figuring out at the ghastly, appalling, impossible sum of seven dollars and ninety-six cents. Our total wealth was two-O-four.

As usual, we tried to get the old folks interested to the extent of a cash investment, with the argument that it would be handy to exchange cake-receipts, or ask who was mayor this year; things like that. Fat chance! Father said we were under his feet most of the time, where he could talk to us vocally without expense. I then appealed to him as a disinterested patron of the arts; but the answer was he guessed if he could keep me in shoes, that would be about the extent of his encouragement of science, the way business was. The enterprise languished and I guess it would have been doing the same yet, but for a big stroke of luck we had.

Just in our time of need the Charles River stepped forward and gave us our line, insulators and all. You know the Charles, because it's the one that Longfellow used to make poems about when he was hard up for subjects and the rent was due.

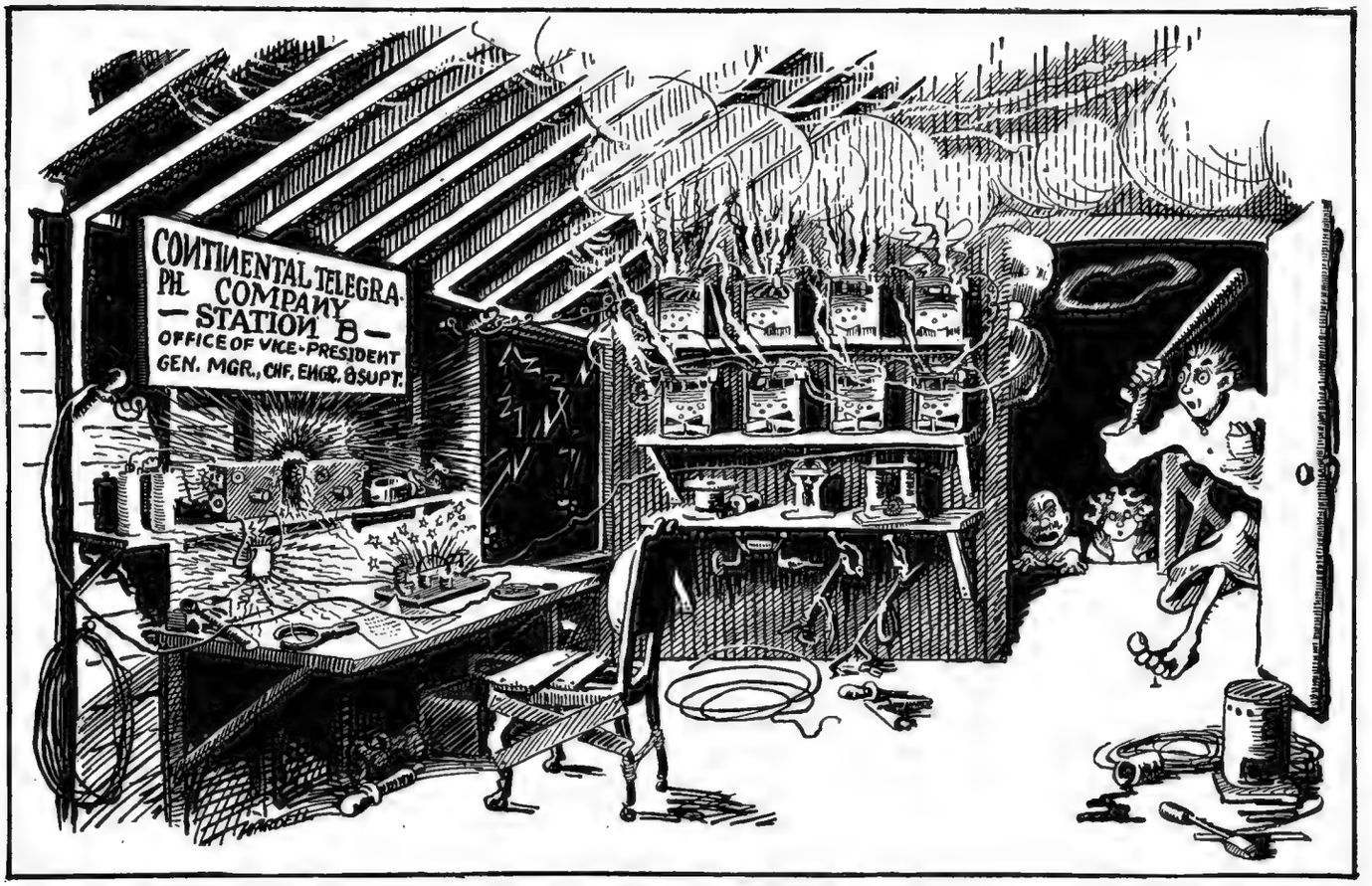
"River, that in silence windest
Through the meadows to the sea,"

and so on, as much as $12 worth, the way they used to pay poets. Such nice language shows what a shady job can be done under a poet's license. He worked that river off on the public at high tide, never mentioning that when the tide was out, it was composed mostly of black mud, dotted with cans, old hats and felines nine times tired of life. That was in the old days, of course; it's all prettied up now and called a "Basin," and if you threw a cat in it a park cop would arrest you just as quick as he would if you pulled a fish out. It's strictly against the law these days to mix the land and water fauna.

Well, among the other curiosities lying on those mud-flats, we spied a big snarl of telegraph-wire, with insulators attached, which had blown off the bridge during some winter storm. We borrowed a boat and grubbed up every last foot of it. It was middling kinky, and more than middling rusty, but, as the fellow says, it looked like a string of pearls to us. We straightened it out and pieced it together. Sometimes we'd have a dozen splices inside of twenty feet, and then it looked still more like a string of pearls—or something.

For all our joy, though, we must have realized that it wouldn't prove exactly an ornament to the suburban home, because I remember perfectly that, when we approached the neighbors for leave to use their houses as telegraph poles, we didn't mention how it looked. They naturally

(*Continued on page 611*)



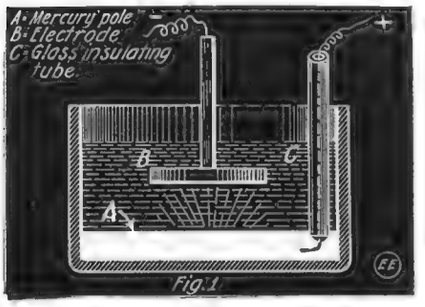
" . . . the thunder storm seemed quite tame when—bing! a tremendous ripping, tearing discharge took place. . . . Hot arcs played about with a sizzling noise. The telegraph sounder tapped wildly, buzzed, stuck, and slowly grew red hot! The batteries boiled and gave off ugly green fumes."

The Marvels of Modern Physics

By Rogers D. Rusk, B. Sc.

COLD LIGHT.

THE above title is a seeming contradiction, because most people are guided by common-sense, and common-sense sometimes goes astray. The impossibilities of today are the commonplaces of tomorrow,

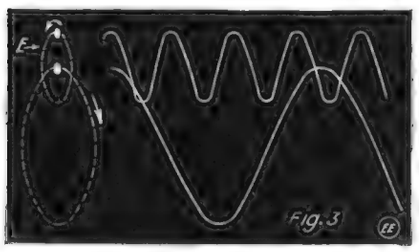


Experimental Production of "Cold Light" by Passing an Electric Current Thru a Potassium Bromid Solution.

and it is a wise man indeed who dares say that such and such a thing cannot be true. Everyone knows that a candle-flame, a gas-light or an electric lamp is hot, but it does not necessarily follow that *all* sources of light are hot. The firefly even after death, and when kept at a low temperature, will still emit the same luminous glow. This luminosity is *not* due to a high temperature, hence we call it cold light, and it is possible in the laboratory to imitate, if not to duplicate the light of the firefly.

One of man's greatest exploits has been the turning of darkness into day. The production and maintenance of efficient lighting systems concerns the whole civilized world, and yet in the electric light it is surprising what a waste of energy there is. Considering the gas-filled tungsten lamp, the most efficient incandescent lamp yet produced, *only 3.3 per cent of the energy expended is turned into light!* Think of the millions of lamps in use in the United States alone, and then consider what might be done with the *96.7 per cent* of the electrical energy now going to *waste.*

The truth in the title of this paper depends upon the fact that under certain conditions light may be produced, when if heat is not entirely absent, at least the temperature is comparatively low, and the materials concerned are cold in the common sense of the word. It is not at all improbable that in the future marked changes in methods of illumination may develop from this physical principle. The subject of light is the broadest in all the realm of physics. Its practical and theoretical aspects interest both the engineer and scientist, and not a small number of the latter are working on the



Showing the Production of Heat and Light Waves Simultaneously by Double Motion of Electron and Molecule, i. e., "Light with Heat."

problems involved in the study of cold light. Aside from the very great theoretical interest of such investigations, the results will doubtless lead to greater illuminating efficiency at least, if not to an entirely new method. The trend of progress in electric lamp invention and manufacture has moved steadily during the past fifty years in the direction of cold light. That is, each succeeding lamp has produced more candle power with less heat loss; and who shall say that in the tungsten lamp we have reached a limit?

The radiation of light from a heated substance is called temperature radiation, and this characteristic of light production is true of all opaque substances. On the other hand, perfectly transparent substances do not radiate light upon being heated. Over a hundred years ago it was found that this is true of air. No matter to what temperature air is heated, it will not radiate light.

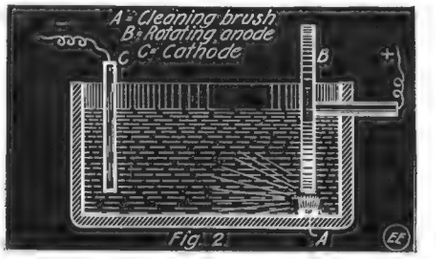
The light in the ordinary kerosene lamp is due to the glowing particles of carbon. A gas jet gives off still more light because the particles of carbon are heated to a higher degree. In the old incandescent lamp the carbon filament could be heated to luminosity with less consumption of energy and without the filament being consumed very fast itself. Then came the tungsten lamp which takes only a fifth of the energy, and whose life is much greater than that of the carbon lamp. Such improvements have been brought about by 1st, the demand for higher illuminating efficiency; 2nd, lower operating costs.

The carbon filament lamp is satisfactory compared with kerosene, except that if made to give a higher light efficiency its life is very short. This is because the carbon vaporizes and disintegrates—i.e., it has a higher vapor tension. The *Osmium* lamp, one of the first metallic filament lamps, was successful because of the low vapor tension of osmium, and increasingly successful were the *tantalum* and tungsten lamps which quickly followed. The large loss by heat radiation in the tungsten lamp has been cut down very greatly by the introduction of *nitrogen* gas into the bulb. Yet, as mentioned above, only 3.3 per cent of the energy is actually converted into light.

It has been said that the light of the firefly is the most efficient form of light known. We can hardly estimate the cost of such production, but certainly there are no great losses to be considered. Nature is ever economical, and we would do well to imitate her.

The theory of cold light can be understood by anyone with a slight knowledge of physics and chemistry. It is well known that light is given off by phosphorescent substances at low temperatures, but this is light which has been absorbed shortly before, and is being given off slowly. During the exposure the substance underwent a stimulation, the effect of which lasted over a certain period of time. If we had another method of stimulating such substances, it is readily seen that a cold light of some practical importance might be evolved. However, it is not particularly these substances to which the theory of cold light refers, but rather to the general scientific causes of the production of such light without temperature radiation. It seems that light produced in this manner must be due to some chemical action, and this action has actually been produced in the laboratory by electrical means. The experiment is even simple enough to be repeated by most any experimenter. First, however, let us see if we can prove that temperature is *not* the only factor concerned in the production of light. It is surprising how some of the simplest facts of experience will help us here.

A pinch of common table salt (sodium chlorid) thrown on a flame will color it yellow. The chemist knows this as the characteristic sodium line of the spectrum, whose position is always the same, due to the unvarying wave length of sodium light. Put the salt in a different flame of quite



Luminescence Produced by the Passage of an Electric Current Thru Sulfuric Acid—Another "Cold Light" Experiment which Can Be Made by Anyone.

different temperature and still the color is the same. Put two different substances of this nature in the same flame, and different colors will be produced. This points to the conclusion that temperature is not the only factor concerned in producing the luminosity. It is not alone a molecular vibration due to the heat, but in addition—a chemical reaction! A complete control of this chemical reaction would give us a means of generating cold light at will.

It is likely that a number of chemical reactions are going on at the same time, making the action a quite complex one. The decomposition of the metallic salt is probably a chief factor, for in the sodium flame a certain amount of free sodium can be found and the same is true of the salts of other metals. Different reactions will produce different colors, and altho a complete tabulation of such experimental data has not been made, to include the multiplicity of reactions known to the chemical world, still some progress has been made along this line recently.

If we pass a current of electricity between two electrodes thru a suitable electrolytic solution, flashes of light will be noticed at the *anode* due to a light-giving chemical reaction started by the current. The production of light thus by chemical means is called *chemiluminescence,* and the light is only visible in flashes due to film formations in the electrolyte. The best results can be obtained by the following method illustrated in Fig. 1. Mercury in the bottom of a jar is made the *anode* by connecting with a wire thru an insulating tube to the surface, and a strong solution of potassium bromid placed in the jar. With a current of about two amperes per square decimeter of mercury surface, the mercury will glow with an orange light. The cur-

Light Waves From Motion of Electron Alone. Here We Have Heatless or True "Cold Light."

rent can readily be varied by changing the applied voltage which may be as low as four volts. By using a brush pressing against an anode in the form of a rotating wheel B, as shown in Fig. 2, light may be

(*Continued on page 616*)

Editor's Mail Bag

Under this heading are published communications from our readers of general interest to all concerned. In order that letters shall receive proper attention, we earnestly request you to make them as short and concise as possible. This is essential on account of the great amount of mail received daily.

No attention can be paid to unsigned communications, but on request we will withhold the correspondent's name.

EDITOR.

A PROFESSOR'S VIEW.

Editor The Electrical Experimenter:

As you appreciate brevity I will not take up much of your space in criticism and suggestions. It is simply this: THE EXPERIMENTER has been and is exceedingly useful to me as Professor of Natural Sciences in the St. Francis College. I think that the department of Experimental Chemistry is a good addition to the journal and I hope that THE EXPERIMENTER will continue in its present form.

I have recommended THE EXPERIMENTER to several of my friends interested in electricity. REV. MARCUS KREHE.

Cincinnati, Ohio.

[*This is one of the many letters we have received lately commenting on our new department, Experimental Chemistry. Next to Wireless, this new department has been most heartily received by all experimenters, worthy of the name. Of course the most interesting installments are to come as yet. We are certain that Experimental Chemistry will make hundreds of new friends during the coming months.—Editor.*]

FROM A BUSY MANUFACTURER.

Editor The Electrical Experimenter:

Perhaps you have noticed that I do not often enthuse, but I must at this time congratulate you on your November number. Harking back to the first few numbers that you published, the changes have been so rapid and numerous, as to seem wonderful. We hope that the EXPERIMENTER will be an ever-growing factor in its field.

Feeling that some of the credit is due to your associates as well as yourself, to those with whom I am acquainted, I would be pleased to have these congratulations extended also.

KNAPP ELECTRIC MFG. CO.,
DAVID W. KNAPP, *Pres't.*

New York, N.Y.

[*In the course of a day many letters reach the Editor's desk. Not a few of them bring good cheer and make us feel that what we do is appreciated. So when the average "Bug"—Mr. Edison calls them "Muckers"—writes us sixteen pages telling us how much we are helping him—why, of course, Editors are human after all—we naturally feel happy about it.*

But when a manufacturer, employing several hundred hands, and who, like many more just now has serious labor troubles and infinite troubles trying to get his skyrocketing materials, and a host of other perplexing troubles . . . well, then, when such a man finds time not only to read our magazine, but also finds time to dictate a letter, in these strenuous times, we indeed feel that we are fulfilling our mission. It puts steam in us and induces us to work even harder—if that were possible just now!—Editor.]

YES, THE GENTLER SEX READS THE "E.E." TOO.

Editor The Electrical Experimenter:

No doubt if some of your male subscribers were to read my letter they would say: "Here's another suffragette; one is always sure to pop up where she's not wanted." No, I'm not. But I would like to mingle my praises with theirs for THE ELECTRICAL EXPERIMENTER.

My husband subscribed for your magazine for a year and I have read it through with as much (if not more) interest as he has. I have greatly enjoyed Baron Münchhausen's Adventures and have read them with as much interest as one of the weaker sex is supposed to have in the latest love story. I also enjoy your "Phoney Patent Offizz," "Wireless Wiz," "How-to-Make-It Department," "With the Amateurs," etc., in fact, there is little that does not hold my attention. I have in my home a number of little conveniences which have been copied from your magazine. Now that our subscription has expired, my husband asked me to renew it for one year, but I have managed to renew it for two years. I hope I am not too late to take in your last offer at $1.00 per year.

I wish you much success and also hope that THE ELECTRICAL EXPERIMENTER will continue to prosper and grow better, much better as it grows older.

MRS. J. J. NUESSLEIN.

West New York, N.J.

[*We might as well admit it; we are not burdened with many letters from the gentler sex. Somehow, as a rule, electricity does not hold many charms for our fair sex. Therefore the above letter is all the more appreciated. We certainly do try to make the "E.E." better, MUCH better as we go along. Sometimes we think we do make a mess of it; of several late issues only the November number fairly well satisfied us, but we promise to do better.—Editor.*]

THE JANUARY, 1917, ELECTRICAL EXPERIMENTER.

Start the New Year right! Become a regular reader of this journal and be up-to-the-minute on the latest electrical, scientific and wireless topics. The Electrical Experimenter not only tells you first-hand about all these things, but just how they work. That's what we're here for—to cater to the curious and seekers after knowledge. You can be entertained and educated simultaneously by reading the "E.E." Why not have it arranged so that "your favorite magazine" reaches your library table, as well as that of your friends, by mail? Can you think of a better Xmas gift than one solid year's reading—nearly a thousand large pages of meaty, valuable, scientifically accurate data. The "E.E." fills the bill from Soup to Nuts. Here's the first course for 1917! Why miss the others? It's up to you.

Electricity's Rôle in the Mining and Refining of Gold, with some exceptional photographs. Learn how a Klondike stream six miles long is heated by electricity.

The Radio Obliterator—A Marvelous Wireless Apparatus That Will Interfere with Any Radio-Controlled Device.

How Railroad Trains Electric Light Themselves.

How to Read Your Own Electric Light Meter. By Walter F. Current.

Baron Münchhausen in Another Discourse on Martian Affairs. By Hugo Gernsback.

When Electricity Puts Out the Fire.

Third Handsome Supplement Photo of a Famous Electrical Scientist.

Action of Detectors in Wireless Telegraphy. By Wilder D. Bancroft.

Inductance—Its Calculation and Measurement.

The How and Why of Radio Apparatus. Part 2—Transformers. Explains Just How They Operate and Why.

Also the Announcement of Results in the $25.00 Interrupter Contest.

AN INDEX FOR OUR QUESTIONS AND ANSWERS.

Editor The Electrical Experimenter:

Reading the *Editor's Mail Bag* and the note "To Our Friends" in the *Question Box* of the September issue reminded me of an idea which I have several times thought would be a big help to your magazine and reduce the number of unnecessary questions.

For example, I would be doing a certain experiment and some question would come up. I would remember seeing it treated in the EXPERIMENTER so I would get out my file and hunt for several hours without finding it and would then try to get along without it, or be prompted to write to you.

On the other hand, a question would come up and I would not know whether it was treated in the EXPERIMENTER, but since there are so many articles in each number, I would not look in it because the job of finding the information would be difficult.

Why not publish a handy index each month in which each article is listed under its various heads, and once a year publish another index which would give the same sort of a list for all issues of the EXPERIMENTER to date? It should include everything in each issue: *Question Box*, amateur stations, etc.

To save space and type, the monthly and annual indexes could be arranged in an abbreviated form having letters and figures represent the subjects and number and page, something like a modern library catalog. For instance, A.C.D. 41, 352 would indicate a subject D. under the sub-division C. of the general subject A on page 352 of the whole number 41 of the EXPERIMENTER.

Altho your magazine is quite valuable now, I believe some such plan would increase its value immensely.

PAUL H. SHNEY.

Pittsburgh, Pa.

[*Several letters similar to the above are received by us weekly. The suggestion is a very good one, and only lack of valuable space deterred us from carrying it out.*

We have, however, a plan under way whereby we will shortly publish one or more 25 cent books which will contain all the Questions and Answers that have been printed in the "EE" since the first issue. We believe a book of this kind, properly indexed and cross indexed, will be welcomed by most of our studious readers.—Editor.]

MAMMA'S JOKE.

"Oh, mamma, the hen is sitting on the vacuum cleaner!"

"Perhaps she's trying to lay the dust, dear."

The RADIO LEAGUE of AMERICA
HONORARY MEMBERS
CAPT. W.H.G. BULLARD, U.S.N. NIKOLA TESLA.
PROF. REGINALD FESSENDEN. DR. LEE DE FOREST.
H. Gernsback, Manager

Western Radio Amateurs Offer Their Stations to Army

A SHORT while ago, when there was general public excitement over the delicate Mexican situation and the President had ordered a mobilization of the National Guard in practically every state in the Union, two Western wireless enthusiasts, Messrs. Frank L. Brittin and Russell C. Workman of Springfield, Ill., tendered the use of their excellent radio plant (illustration of which is given herewith, as well as portrait of Mr. Brittin) and their services to the Illinois National Guard.

The offer was gratefully accepted by the Adjutant-general. The radio installation here shown is installed at the Brittin Drug Company's store at Springfield, of which Mr. Brittin is one of the proprietors.

These up-to-the-minute wireless enthusiasts thoroughly enjoy operating their outfit. They have transmitted messages as far as 280 miles away with their sending apparatus.

Adjutant-general Dickson was greatly interested in the offer extended for the use of the plant to the National Guard and also in the offer of the young men to assist his engineering corps in the construction of field wireless apparatus for use in camp and at the front.

This tender was all the more welcome, so far as the National Guard was concerned, for the reason that the Illinois troops were not equipped with field wireless outfits.

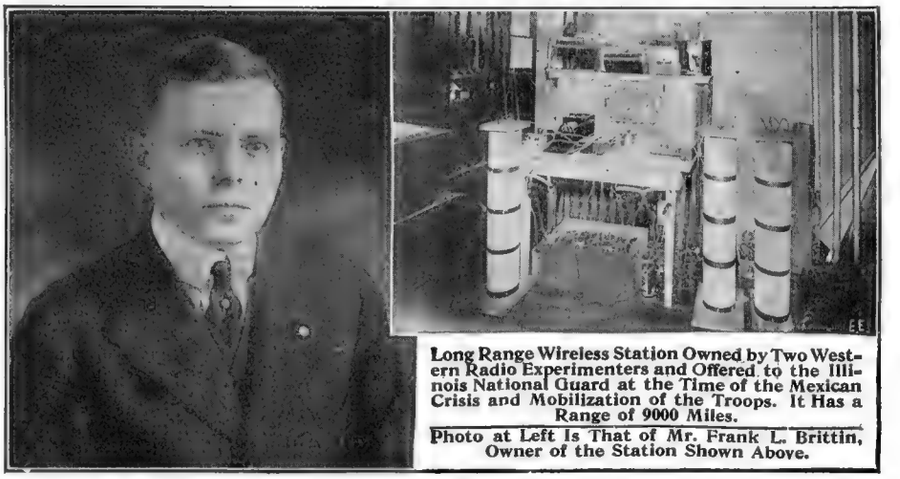
A number of original ideas worked out by Messrs. Brittin and Workman, but on which no patents have been taken out, were offered for sale to the State, providing Adjutant-general Dickson and his engineers wished to try them out.

Referring to the illustration of the apparatus and as most every thoro-going radio amateur well may surmise, this station is equipt for long wave undamped signal reception. For this reason there are used extra large inductances, which may be seen clearly in the illustration. These gigantic coils measure 32 inches in length by six inches in diameter, and each one is wound in four sections with No. 22 cotton covered copper magnet wire, the total amount of wire used being eight pounds. The Audion detector and amplifier is used for receiving both damped and undamped signals and the hook-up is the extremely flexible and well-known Armstrong circuit.

Another interesting fact concerning this station is that these clever radio workers and experimenters have been able to successfully receive two or more different stations simultaneously on one aerial, by hooking up two or more loose couplers to it. So well arranged is this multiple-tuning scheme that it is possible for one operator to be receiving from Germany while another operator is picking up the far-flung dots and dashes from distant Hawaii.

The receiving range of this most interesting station is truly remarkable and is stated to be close to 9,000 miles. The stations successfully copied at this Springfield experimental laboratory, by Messrs. Brittin and Workman, include OUI—POZ—WGG—WSL—NAJ—HO, and a long list of other high-powered stations of both the damped and undamped type.

The station is operated under a Government license, the official radio call being 9AGN.



Long Range Wireless Station Owned by Two Western Radio Experimenters and Offered to the Illinois National Guard at the Time of the Mexican Crisis and Mobilization of the Troops. It Has a Range of 9000 Miles.

Photo at Left Is That of Mr. Frank L. Brittin, Owner of the Station Shown Above.

A NATION-WIDE PRESIDENTIAL RADIO RELAY.

Proposed legislation that endangers our right to operate our wireless stations must be met with a determined effort to show our worth to the public as a factor in the general scheme of national defense and preparedness, says W. H. Kirwan in a circular sent broadcast to radio amateurs all over the United States.

On the night of October twenty-seventh, and for the first time in the history of this grand Republic, the radio amateurs demonstrated to the public that they can be relied upon to help the Government.

The purpose of the Presidential relay was firstly, to get the amateurs interested in perfecting their stations. Secondly, as the ether was perfectly quiet on the night of the Relay, it gave them a chance to check up their receiving outfit. Thirdly, to get a number of good receiving stations that can hear NAA and NAJ, at all times. This list was turned over to the Government authorities. Fourthly, to satisfy the curiosity of the President of the United States as to their real worth, and assist the Department of Commerce, all of whom have rendered the amateurs valuable assistance. Fifthly, to give prizes to the most successful amateurs.

The message originated from Station 9 XE, in Davenport, Iowa, and was relayed thru the following stations, on the night of the twenty-seventh of October at 10:00 p.m., Central Time. Starting from 9 XE on low power, the MSG (message) was relayed automatically by Dr. Hall's famous recording relay device at Station 9 XR.

Every amateur was instructed to keep quiet himself until sending stations had finished. Then, by previous arrangements effected by each amateur, this message was relayed to all parts of their state. They were further admonished to listen to NAA and NAJ on the nights of the twenty-fifth, twenty-sixth and twenty-seventh of October after their routine reports and to give this story at once to their local newspaper and to notify every near-by amateur to listen. The sending stations were selected because they represent some of the best amateur stations in the country, with the exception of 9 XE, which, of course, has never boasted of any great ranges.

A number of valuable prizes were offered including a 1 K.W. Thordarson Transformer; a Tubular Audion Panel mounted and ready for use, a pair of 3,000 ohm 'phones; a pair of 2,000 ohm 'phones; ten 2 filament Tubular Audion bulbs and twenty free subscriptions to a wireless magazine.

The amateurs in the many states had to keep an eye on President Wilson; Vice-president Marshall, and Mr. Hughes. It was up to the amateurs of the several states wherever these gentlemen happened to be, to give each of the above a copy of the message. The amateur landing Mr. Hughes or one of the other two personages became the "first prize" winner. All answers to the relay, including signatures, etc., had to be mailed not later than elec-

(*Continued on page 620*)

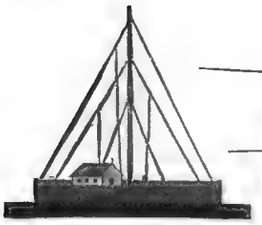
DO YOU

own a wireless station, either for sending or receiving? If you do, don't fail to join the greatest Wireless Association in the country: THE RADIO LEAGUE OF AMERICA. If you believe in the preparedness of your country, if you wish to help Uncle Sam, if you wish to have your station officially recognized, join the LEAGUE, a national, non-money-making organization. Beautiful engraved and sealed certificate, FREE to all members. NO DUES OR FEES WHATSOEVER.

Honorary Members: W. H. G. BULLARD, U. S. N.; PROF. REGINALD A. FESSENDEN; DR. LEE DE FOREST; DR. NICOLA TESLA.

Send stamp for large 8-page information booklet.

DO IT NOW. 233 Fulton St., New York City, N. Y.



RADIO DEPARTMENT

The Arlington Radio Station (N A A).

By Capt. W. H. G.Bullard, U. S. N.

DASH DOT! Dot Dash! Dot Dash! (NAA) is the signal of delight which radio amateurs all over the United States listen in for at 12 noon and 10 p.m. daily. At these hours Arlington sends out the correct time *via radio* which is received by amateur and commercial stations for a radius of 3,000 miles and more. The Arlington station, located at Radio, Va., operated by the U.S. Navy Department, signs the call of "NAA."

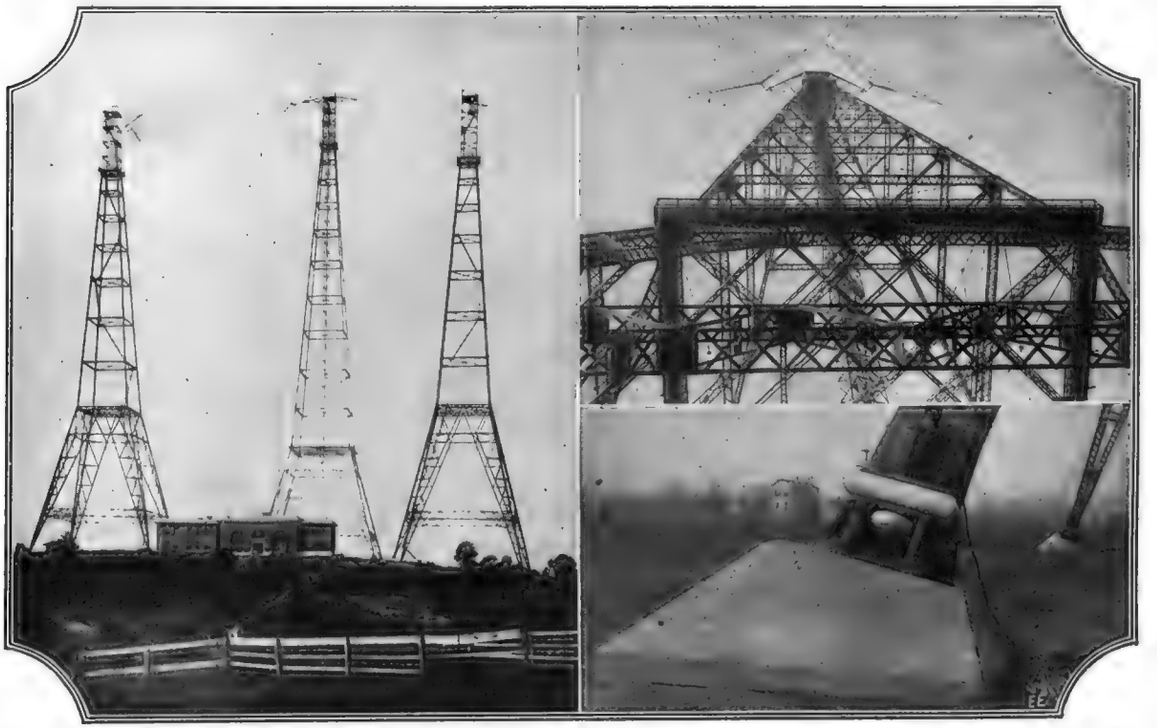


Fig. 1, (at Left) View of the 450 and 600 Ft. Skeleton Steel Towers at Arlington (NAA) from where Uncle Sam Sends Out Wireless Messages to Battleships Thousands of Miles Away. Fig. 2, (upper right) View Looking Up One of the Masts. Fig. 3, (lower right) Base of a Mast, Showing Massive Insulator and Lightning "Ground" Wire.

The accompanying photographs and diagrams illustrate some of the interesting constructional details of the towers and wireless apparatus.

The site finally selected, being the present one, was formerly a part of the Government Reservation known as the Fort Myer Military Reservation, and the ground, 13.4 acres in extent, was transferred from the War to the Navy Department by act of Congress. A general view of the towers of the station after completion is shown in Fig. 1 while Fig. 2 shows the view looking up one of the masts and Fig. 3 the base and ground lead of one of the massive towers.

The average elevation of the space on which the towers are built is about 190 feet above sea level. The view shows three skeleton steel towers, one 600 feet high from the ground, the other two each 450 feet high. The centers of the towers form an isosceles triangle, the base of the triangle being 350 feet long and the altitude 350 feet. Fig. 3 shows one tower leg with its insulation switch and short-circuiting switch. The base of the triangle, the distance between the two shorter towers, runs approximately magnetic north and south. Two hundred and seventy-five tons of steel were used in the construction of each of the smaller towers, and 500 tons in the larger one.

The current as supplied is 3 phase, 25 cycle, 6,600 volts; and after entering the basement it is transformed to 220 volts.

The first set installed in the Arlington station was a spark set constructed on the Fessenden system. The main driving unit is a 200 horse power, 220 volt, 25 cycle, 3 phase synchronous motor, 300 revolutions per minute, controlled by means of an oil switch with auto-starter. On this motor shaft, and driven by it, is an 8 kilowatt, 110 volt, direct current generator which is used to excite the fields of both the 200 horsepower driving motor and the driven 100 kilowatt A.C. generator, which furnishes the energy for the transmitting apparatus of the radio set.

The 100 kilowatt A.C. generator is a 220 volt, 500 cycle machine, and is driven at 1,250 revolutions per minute thru a leather belt by the 200 horsepower motor. On the generator shaft is the rotor, or moving portion of the synchronous rotary spark gap, which consists of a fiber wheel with a heavy brass ring on its outer circumference from which protrude 48 copper tractors, each about ten inches long. (This spark set was illustrated in the Dec., 1915, ELECTRICAL EXPERIMENTER.) The bearing at this end of the generator is specially constructed with a large flange 70 inches in diameter, which supports the casing for the gap rotor. The casing, which carries the stationary electrodes of the spark gap, is fitted so that it can be moved backward or forward by a worm gear. Provision is made to cool the stationary electrodes by running water thru them. The requirement that the stationary electrodes may be moved is very essential, as any small changes in the variable factors which produce changes of wave length tend to cause the sine wave of the alternator to lead or lag, and it is necessary to move the electrodes so that the sparking will occur at the *peak* of the wave in the condenser charging current.

The main leads of the generator run to a panel on the switchboard, and after passing thru a circuit-breaker, carry current to the primary of the transformer. The wiring diagram is shown in Fig. 4. One of these leads is broken by a large relay key, and shunted around the relay contacts is a large, variable current capacity, resistance grid which takes care of the considerable current in the primary from the time the cirruit-breaker is closed until the condensers are almost up to the point of discharge. When the key is closed and opened the greater part of the current is taken up by the grid, and this serves the double purpose of protecting the contacts from wear and of keeping the condensers constantly up to the sparking point, ready for instant discharge. This relay key is operated by a small sending key in the operating room or at any other distant point.

The secondary leads carry current from the transformer at 25,000 volts to the stationary electrodes, and shunted across the electrodes is the usual closed circuit, containing the H. T. condensers and primary inductance of the oscillation transformer in series.

The primary inductance is a special helix made of ten turns of one inch copper tubing about four feet in diameter, fitted with suitable spring clips by means of which the leads can be clamped to any turn desired for varying the sending wave lengths.

The condensers used are of the *comprest*

air type. Each consists of a large cylindrical metal tank in which the plates (about 200) are suspended; one set being connected to the tank itself, and the other set connected by a rod thru an insulator running thru the center of the cover. A lead washer under the rim of the cover and a lead bushing around the insulator, insures the tank being air-tight. The plates are spaced one-eighth inch apart, and at that distance would not stand the high voltage were it not for the comprest air.

Each condenser has a capacity of 0.036 Mf. (microfarad); 14 units being used in multiple series (two sets of seven in parallel and two sets in series).

The secondary of the oscillation transformer is made up in the same manner as the primary, but is of three-eighth inch copper tubing and has twice the number of turns. One lead is taken off to a hot wire ammeter and from there to the ground; the other lead has a spring clip and can be connected to any turn of the loading coil or antenna inductance. The adjustment of the oscillation transformer is made as nearly correct as possible before the spark is turned on; then the loading coil, which has similar contacts, can be revolved while the spark is in operation so as to bring the antenna (and secondary circuit) into resonance with the primary. This is done by watching the reading of the hot wire ammeter and moving the loading coil until maximum antenna current is obtained.

The primary of the oscillation transformer has a screw attachment by means of which the primary can be moved farther away or nearer to the secondary, so to obtain the proper amount of coupling to ensure a sharp or pure wave,

The antenna lead is taken from the loading coil to a switch on short masts outside the building, the lead passing thru an Electrose insulator fitted in a plate glass one inch thick and five feet square! The switch on these masts is controlled by a lever and sprocket chains from the *sound proof* operating room.

The huge antenna is made up of three sections, 23 wires in each section, each wire consisting of 7 strands of number 20 phosphor bronze. (Diameter of number 20 wire=0.032 inch or 0.081 cm.) These wires are attached to spreaders made up of three inch pipe, 88 feet long, reinforced by trusses; and the spreaders are attached to the towers by 10 Electrose insulators between them and the towers. A general plan view of the construction of the antenna is shown in Fig. 5. It is open at the highest end, at the 600 foot (183 m.) tower, and two sections are brought down to the 450 foot (137 m.) towers and there joined to the main section by *jumpers*, made up of 23 wires bunched in the form of rope. The main section is what is known as a "T" antenna, and the vertical part (*rat-tail*) is taken from the center. The 23 wires of the rat-tail are brought down in the shape of a fan for 300 feet (92 m.) and then in the form of a large cage the rest of the way to the switch on the short pole-mast.

Fig. 6. The 100 Kilowatt, Undamped Wave, Arc Transmitter at Arlington (extreme left) and Huge Tuning Inductances for It.

The above antenna arrangement gives a fundamental of 2,100 meters with a capacity of 0.0094 Mf., and can be readily switched over by means of a switch on the pole mast for use in *transmitting* or *receiving*. In the latter case it forms a very efficient arrangement for receiving long waves, as it is not necessary to insert an inductance of necessarily high resistance. For receiving shorter waves, a small antenna has been put in place at a height of 300 feet (92 m.) and is used also in transmitting with a 5 kilowatt quenched gap transmitter, which is installed for local work, such as that with Philadelphia, New York and Norfolk and with nearby ships.

The ground connections consist of many lengths of wire buried in the ground at various depths in the space near the towers, and laid in a perfect checker-board

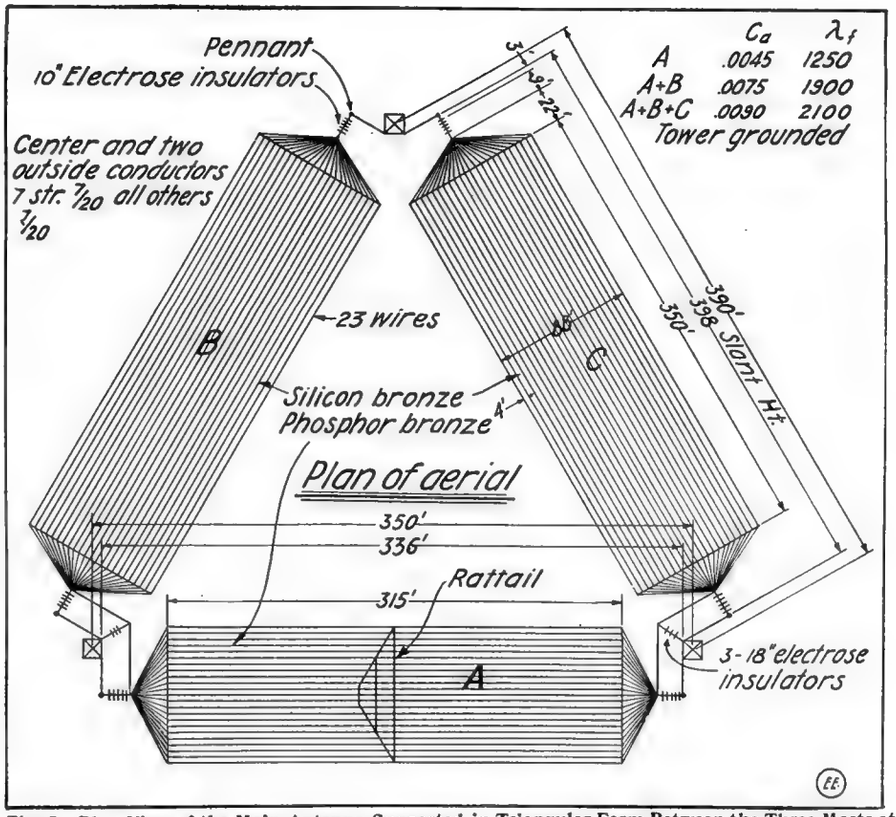


Fig. 5. Plan View of the Main-Antenna Supported in Triangular Form Between the Three Masts at Arlington, with the Rat-tails Taken from the Middle of the 350 Ft. Central "T" Span.

pattern with soldered junctions. Miles of this wire were laid, making a large network and finally heavy wire leads are run down the slopes ending in a small stream that flows near by. The ground connection between the antenna and this net-work is made thru a large copper strip 6 inches (15.2 cm.) wide and ¼ inch (6 mm.) thick, run to the ground wires and permanently soldered to them.

The receiving or operating room at Arlington station was built to be *sound-proof* and is constructed somewhat like a refrigerator with double doors and walls *20 inches thick!* Before the plastering was put on, the ceiling, walls and floor were covered with a ¾ inch (1.9 cm.) "Linafelt" for sound-proofing, and then a layer of chicken wire of ¼ inch mesh was secured over the Linafelt. The meshing was carefully (electrically) connected together, and then several strips of copper were soldered to it and taken to the ground connection outside the building to make a *screen* for the receivers, so that any induction effects from the generator would be absorbed by the screen.

The room is ventilated by two small fan motors, 220 volt, 25 cycle, 3 phase and the air ducts have *baffle plates* lined with felt on the same principle as a muffler or Maxim silencing device, so that the air is silent when it reaches the room. In the air duct is a radiator from the heating system to heat the air for the room in winter months.

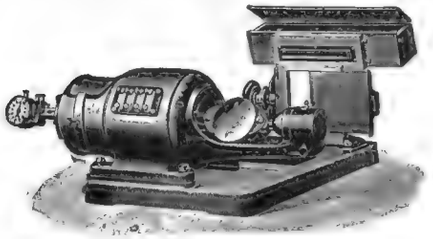
The *5 Kilowatt Spark Set*: The second set installed in the Arlington Station was a 5 kilowatt spark set. The motor generator of this set, which was especially designed for this station, consists of one 15 horsepower, 3 phase, 25 cycle A.C. motor, one 10 horsepower D.C. motor, and one 5

(*Continued on page 610*)

The Revolving Mirror for Determining Spark Characteristics

By Samuel Cohen

ONE of the most interesting pieces of apparatus that a radio experimenter or investigator can possess is a revolving mirror used for observing and recording the frequency of a spark discharge, and also the time between two succeeding sparks. The apparatus as described, can readily be constructed by the average experimenter who

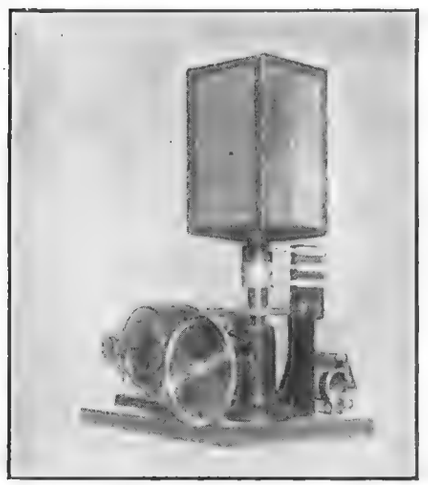


Typical Revolving Mirror, Motor, Speed Counter, Photo Plate Holder and Oscilloscope Tube as Here Described.

possesses simple wood and metal working tools. The complete instrument in detail is shown at Fig. 1, while its operating position is shown in Fig. 6.

The essential parts of this revolving mirror apparatus are the mirror, supported on a suitable frame and revolved by an electric motor, a speed indicator, an oscilloscope tube (used instead of a spark gap), and a plate holder containing a photographic plate.

The various parts will be individually described in detail. The first in consideration will be the revolving mirror mechanism. This consists of a hardwood base 12x5x1 inches, upon which two uprights, D, are mounted. These uprights are made from the same material as the base, but ¾" in thickness, while the balance of the dimensions are given in Fig. 1. A ⅜" hole is bored in each end of the standards D, ¾" from the top as seen in the end view, and

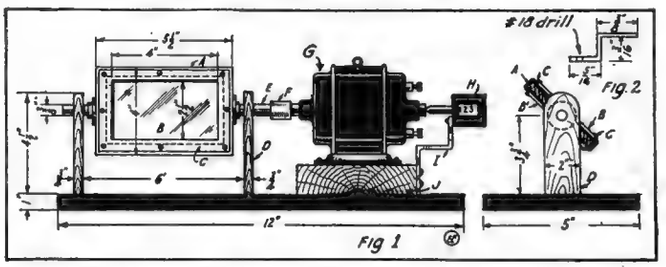


A Different Style of Revolving Mirror with Brushes and Commutator for Opening and Closing Spark Generating Circuit.

these are used to support a shaft E. The supports are then fastened to the base by means of three 2-inch wood screws. The distance between the upright bearings should be 6 inches.

The next piece for consideration is the mirror B and its frame A. The frame is made of smooth, flat strips of wood, such as mahogany or birch, the dimensions of which are 5½x4x1¼ inches. On the ends of the frame two small metal flanges are fastened, exactly in the center, by means of small wood screws, and on one is secured a brass shaft E, about 1½" long by ⅜" in diameter, while on the other side a similar shaft is placed, but this is 3 inches in length. These shafts can be fastened to the flanges by either threading them or else by soldering the shaft and flanges together. The former is preferable. Having fitted on the shafts, the complete frame is then set into supports D.

Two well-silvered mirrors are now obtained. They are ordinary flat mirrors, 4x2½ inches. A great deal of care should be taken to see that the polished surfaces are not scratched, as the successful operation of the complete apparatus depends upon the condition of the mirrors and the manner in which they are handled. The mirrors are secured to both sides of the frame, by means of light brass strips, bent to the form indicated in Fig. 2. The two long strips are 5⅜" while the other two



Working Drawing for Constructing Two-reflector Revolving Mirror Unit.

are 3⅞" inches long. Each is fastened to the frame by three round-head wood screws. Care should be taken to see that the screws are not tightened too much, as it may cause the mirror to crack when the frame is revolved at high speed. It is therefore advisable to place strips of felt between the clamps and mirrors.

With the mirror and its frame carefully set into their proper places, the motor G is set up. This can either be of the battery or 110-volt type. The motor is mounted on a wooden block J, the dimensions of which are not given in the drawing, as it depends entirely upon the size of the machine, and if a high motor is used the block will be unnecessary. The motor and mirror shafts are rigidly connected by means of a collar or sleeve F, which is made from a brass tube about ⅞" long, with a diameter large enough to permit of boring a hole for the motor and mirror shafts. On the opposite end of the motor shaft a revolution counter (speedometer) H is fastened by means of a bracket shaped as indicated by I in Fig. 1. The completed instrument should be carefully sand-papered and finished with shellac.

The instrument is now ready for use. The first step is to test the mechanical strength of the parts when the complete device is in operation. Care should be taken to see that no obstacles are near the revolving mirror, as it may mean damage to the instrument and other objects which are near by. Do not stand in direct line with it when first trying it out.

The first experiment is to observe the number of smaller sparks that produce the single large spark, visible to the human eye. To do this it is necessary to place a spark gap about six inches away from the revolving mirror, and connect it to some high voltage device, such as an induction coil, transformer or Wimshurst machine. Now by permitting a discharge to pass through the gap and by revolving the mirror at high speed, the image reflected in the mirror will be somewhat like that illustrated in Fig. 3. It should be understood that the experiments herewith outlined are to be carried out in an absolutely dark room.

In order to obtain the best results from the apparatus, a special type of spark gap in the form of an *oscilloscope tube*, Fig. 4, is needed. It consists of a glass tube with two plain electrodes. The tube is filled with nitrogen gas under slight pressure. These tubes can be obtained for about two dollars from dealers in X-Ray apparatus. This tube is connected through a very high resistance, such as a tube containing water. The image obtained from this arrangement is shown in Fig. 5. The oscilloscope tube is usually kept in a box, so that it will not be damaged. Fig. 6 shows the complete arrangement of the revolving mirror tube case and the photographic plate holder for permanently recording the spark train on a photo plate. The long slit in the front of the case allows the constantly varying light of the tube to pass through to the mirror. The length of the opening depends upon the size of the tube. The shape and size of the case can be made to suit the experimenter, as it is a minor point in the operation of the apparatus.

Fig. 3. Photograph of Spark Image Observable on Revolving Mirror Here Described, the Spark Occurring in Plain Gap.

One may ask what is the value of this instrument to the electrical and radio experimenter? The question is most readily answered in this way. Suppose it is necessary for one to determine the shape and characteristic properties of a certain alternating current, produced either by an alternator, spark or arc, transmitter. This can be done firstly by plotting a curve of the current by obtaining different values of it during certain intervals of time and then tracing the curve, but it requires complicated and delicate recording instruments; secondly, the curve can be actually photographed by employing the apparatus described. Then the curve can be measured at different points, thus giving the

exact conditions of the current at any interval. In either case the latter method is usually best adapted for general work, as it

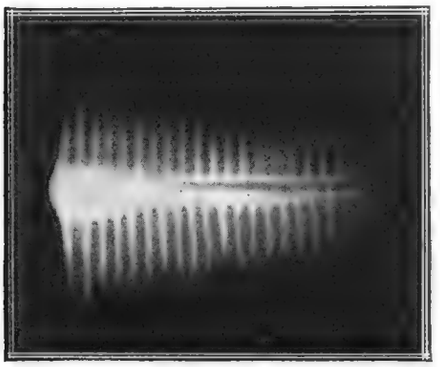


Fig. 5. Photograph of Spark Train as Obtained with Oscilloscope Tube Apparatus Shown in Fig. 6.

is far more simple to handle than the former.

Let us take an example: Determine the characteristics of a damped wave (spark) radio transmitter. The oscilloscope tube is connected in series with the ground and the apparatus excited in the usual manner. If the spark image is observed in the revolving mirror, it will be noticed that a series of damped waves or flashes occur, and if one desires to record these it is only necessary to put a photographic plate in the holder, and place it below the tube case as indicated in Fig. 6. The revolving mirror will reflect the light emitted by the oscilloscope tube to the plate, and cause an impression to be registered upon the latter, which is then developed and fixed just as if it were exposed in a camera.

The only difficulty encountered in recording the wave in this way is that, a series of waves are simultaneously recorded on the plate, which makes it impossible to detect the one which is required, owing to the unequal exposure of the plate. A very simple method of overcoming this is to operate the high tension transformer or coil for very small intervals of time, corresponding to a *dot* or short closure of the key. In this manner a single spark train image can be obtained. Another method of obtaining the same result is to slowly remove the slide in the plate holder until the entire plate is exposed and then instantly shutting the power off. In this way a continuous image of the wave is obtained. A moving picture film can be successfully employed in recording continuously the spark image obtained from a definite transmitter under continuous test when desirable.

In order to obtain the frequency of the oscillations which have been photographed on the plate, it is only necessary to determine the time between two adjacent light strips of the image. The group frequency is obtained by noting the speed of the mirror per second, and multiplying this figure by 2. The result obtained will be the number of group oscillations (complete wave trains) in the transmitter discharge per second. However, it must be understood that the mirror must be revolved at a speed sufficient to make the oscillations visible, thus recording a radio frequency current; i.e., the mirror must be revolved at a higher speed than when a low frequency current is to be recorded. This is best determined by experiment, or by observation at first. The mirror should be regulated when in operation, until a clear image is obtained, or it must rotate in proper step with the groups discharges. The speed is then correct for recording the wave train photographically. In the same manner, undamped waves can be recorded, and their characteristic properties studied. This will also show the working conditions of the transmitter. As an example, suppose the mirror rotates at 60 rev. per sec. when the spark image observed is clear. Multiply this by 2, giving 120 as the wave train (group) frequency. Further, the time period of a single spark, also its frequency, may be determined by knowing the speed of the rotating mirror and the dimensions of the apparatus, which gives the velocity with which the spark image moves across the photographic plate. The distance between two adjacent light peaks corresponds to the time of a half period of the oscillation. Twice this value gives the time period of one cycle. The velocity of the image in cms. per second divided by the pitch of a peak in cms. gives the frequency of the oscillations per second.

Mathematically considered the natural frequency N, per second, of condenser discharges is:

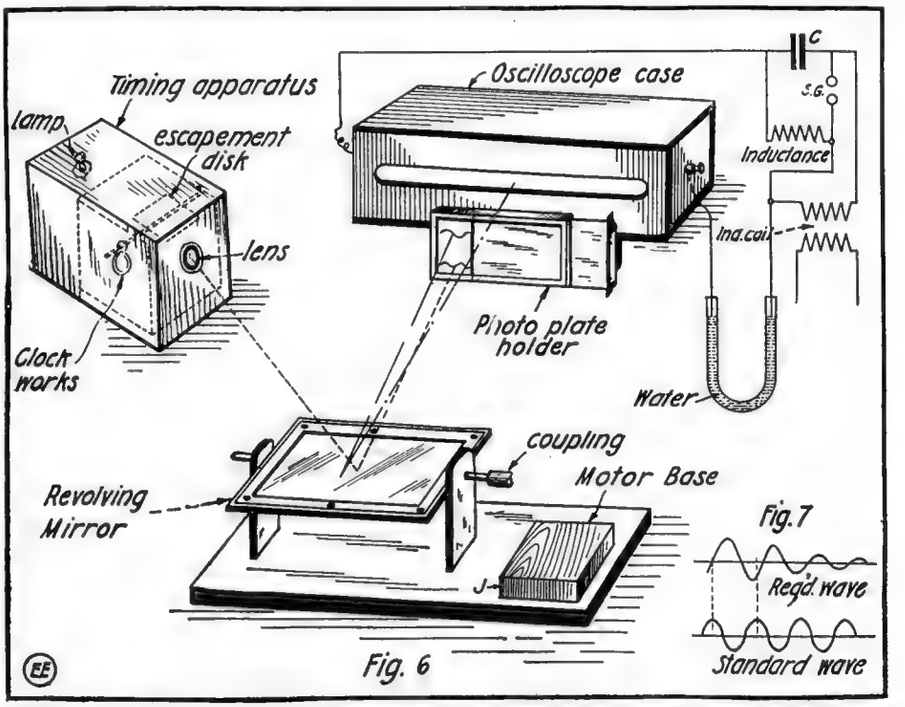
$$N = \frac{1}{2\pi\sqrt{LC}}$$

where L is the inductance of the circuit in henrys C is the capacity in farads. Also the period T of an oscillation is given by the rule:

$$T \text{ in seconds} = \frac{1}{N} = 2\pi\sqrt{LC}$$

The damping of a spark train can be obtained by measuring the amplitudes by means of a finely graduated scale of two successive peaks in the same direction, and dividing the lesser amplitude by the greater one. This will give the percentage of damping of the particular spark used. The logarithmic decrement is obtained by multiplying this result by the natural logarithm (Naperian 2.718), or by multiplying the common Brigg's log. by 2.303 which converts the result to the natural logarithm.

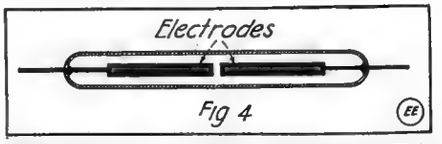
Ordinarily if one desires to obtain the time interval between two successive waves the following directions must be closely followed: First it is necessary to employ an apparatus that alternates at a given known period of time, such as a vibrating diaphragm acting in front of a flame, a rapid discharge of a spark of known frequency or an alternator of known periodicity. Some such apparatus must be used to compare the time of the tested spark and the spark of known frequency. The simplest instrument is the vibrating diaphragm acting in front of an incandescent electric lamp. The vibrating diaphragm apparatus can be cheaply obtained from an old clock, using the escapement wheel as the diaphragm, and close behind it a ten candlepower incandescent electric lamp. Both of these should be placed in a suitable case in front of which an ordinary condensing lens is mounted. A camera lens can be successfully used for this purpose. The speed of escapement must be carefully determined by either counting the number of revolutions by a speedometer or figuring it out by counting the number of teeth of the main drive and substituting the values of every wheel that goes through,



General Lay-out of Revolving Mirror, Oscilloscope Tube, Plate Holder, Spark Generator, and Timing Device Which Reflects a "Known Time Value" Curve on the Plate as Shown at Fig. 7.

before driving the last or escapement shaft. The result must be multiplied by 2; to yield the correct number of alternations given by the diaphragm to the beam of light as it breaks up the light beam twice at every single revolution of the shaft.

Having done this, the next step is to arrange the apparatus as indicated in Fig. 6, and have the light from the electric lamp of the timing apparatus focused on the revolving mirror in such a manner that it will cause the reflected light to fall near the bot-



Oscilloscope Tube in Which Spark Must Take Place to Obtain Results Shown in Fig. 5.

tom of the photographic plate, while the light from the oscilloscope tube is to be

(*Continued on page 590*)

Anent the Audion

By Dr. Lee de Forest†

UNQUESTIONABLY no one invention in the radio art since the original discovery of the efficacy of the upright radiating antenna has aroused so much interest, discussion and futile ire as has the Audion. In fact, the Audion and not the "I.R.E." has put the ire in wireless!

The manner in which the germ idea came to me of the "heated gas" detector, which eventually evolved into the Audion of later years—is probably now too well known to require retelling.*

Suffice it to say that in 1900 I became convinced that in gases immediately surrounding an incandescent body, or electrodes, resided latent forces, or unrealized phenomena, which could be utilized to make thereof a detector of hertzian oscillations far more delicate and sensitive than any known form of detector.

The Commercial Audion was therefore no accident nor any sudden inspiration. It resulted from long hours of search and patient development. I first thought to find the imagined effect in or about the brightly incandescent mantle of a Welsbach mantle. This was in September, 1900. And yet a recent judicial decision has stated that "an incandescent body was the furthest from my thought."

I next explored the Bunsen burner where again I found (not unnaturally) that small platinum wire electrodes in the flame became incandescent. But here I did first find the detector effect I was searching for, and had determined must exist. Next the incandescent gases of an electric arc were investigated; hot mercury vapors of a mercury lamp were considered; and likewise the action in the still more attenuated gases in an ordinary incandescent lamp surrounding an ordinary incandescent filament.

Unfortunately during these years I was given little time to concentrate on any laboratory problem—and yet less opportunity for conducting a line of experiments involving such complications as the construction and exhaustion of various forms of incandescent lamps. Hence, until 1905 I was prevented from putting to actual proof my theories that the same detector which I had predicated and actually found in the neighborhood of an incandescent platinum wire or carbon filament in a gas flame, existed also in the vastly more attenuated gas surrounding the filament of an incandescent lamp. In one case the heat of the burning gases heated the electrodes; in the other the electrodes heated the remnant gases. But in both it was first the electrons from the hot electrodes, and second ionization of the gases which these electrons produced, which established an electrically conducting state, extraordinarily sensitive to any sudden change in electrical potential produced on the electrodes from some foreign source. But how many trailers-after have fought these facts. Here comes Prof. Fleming claiming in his first patent the discovery of the Edison effect (which he had been describing and explaining for ten years prior). Fleming is very explicit as to just what he wants to do—rectify high frequency (as distinguished from low frequency) oscillations—and for one purpose only—to quantitatively measure the same in a D. C. galvanometer. And he is quite honest at first, saying right out that the valve is a poor detector—just like that. However, witness the subjective psychology. In 1908, two years after I had described the two electrode Audion with its "B" battery circuit and its genuine relay action —providing a detector far more sensitive than any other then known—and after a thoro correspondence course back and forth, in the columns of the *Electrician*— Prof. Fleming sees a great light, and brings out a brand new patent, this time showing the "B" battery (masked as a potentiometer across a far too large "A" battery). And now blandly he states that "he finds he can use the 'valve' in another manner." True for the Professor, so he can—and does.

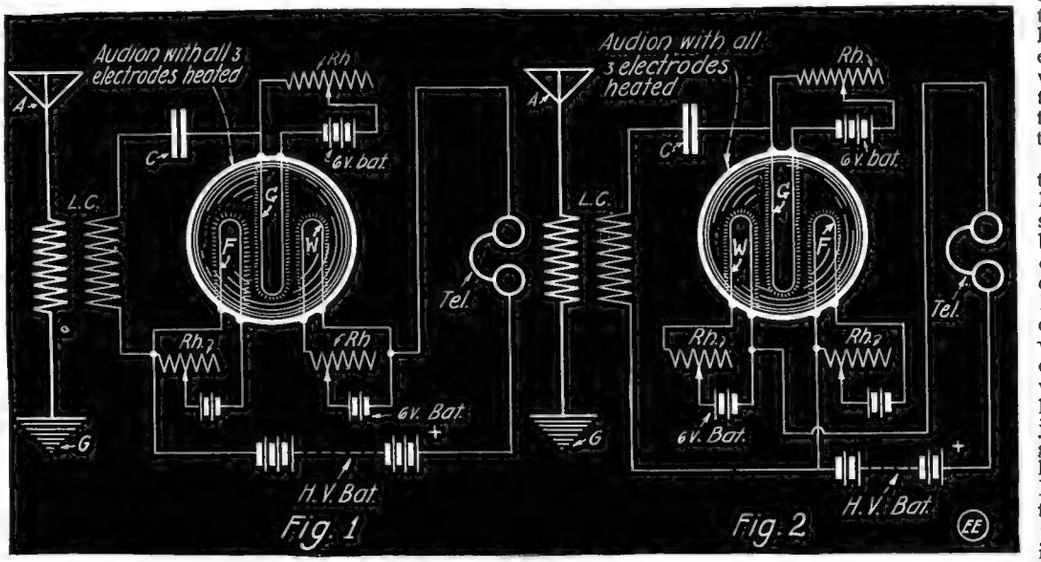
But long before the two-electrode relay-Audion of 1906 had a chance to prove its worth in widespread commercial use, I had found that the influence of the Hertzian impulses could be better imprest on the conducting medium of the Audion from a third electrode. This, quite naturally, was at first outside the bulb, an arrangement "re-discovered" in 1916 by one Moorhead. But if the third electrode outside the bulb was an improvement, why not still better *inside*, where its charges could more directly influence the ions, and electrons, one, the other, or both, which were ordinarily, orderly conducting the current from anode to cathode? So I put it inside —this third electrode—and in the form of a grid. And quite naturally, therefore, I called it a grid—and a grid it was generally termed, until the efficiency and all-around merits of the little member began to become startlingly evident and well recognized. Whereafter certain experimenters (notably Pierce of Harvard) began to write in tardy patents and begrudging text-books, of "screen"—"intermediate-electrode" and what not. Trivialities truly, but strange nevertheless. But "screen," intermediate, input electrode—masked by whatever title you choose—honestly isn't that little grid electrode a veritable nomenclative accelerator? And isn't it the *sine qua non* of every "Gas relay"—"Electron relay"—"Valve relay," "Vacuum tube relay," "Fleming Oscillating Valve," "Pliotron," "Reisz tube," "Thermotron," "Audiotron," etc., etc., ever produced since that contemptible little patent of 1907? And isn't it strange how shy sapient writers on modern radio receivers and generators are, when it comes to describing the trifling part that grid electrode plays in the radio art of to-day?

All this, however, does not deter a number of ambitious investigators from plotting a series of curves—all showing that the principle of the Ediso-Fleming valve controls completely the action of the Audion—that rectification from cold to hot electrode is the key to the whole business. Of which a little demonstration is apropos:—If the three electrodes in an Audion are all made in filament form and all three are heated to incandescence, from separate batteries, the rectification action of course ceases; so that the device used as an Ediso-Fleming valve is a complete failure.

And yet as an Audion detector the bulb works just as well as when two electrodes are cold and only one hot. The "anode" is whichever hot electrode is connected to the positive terminal of the B battery. It can be hot or cold. Ditto the grid—it is whichever electrode connected in the circuit as the "grid" electrode should be connected. It can be hot or cold, indifferently. Any rectification 'twixt hot and cold electrodes is wholly incidental, and is not the Audion action at all.

Of course this one simple little demonstration proves beyond all theory, dispute or cavil, that the Fleming-Marconi school of writers are fundamentally wrong, and yet, looking back just a little, the grid Audion has made good. First there's the telephone relay—licensed in 1913 to the American Telephone and Telegraph Co. There are in use to-day hundreds of Audion Amplifiers, in all the long distance lines of the Bell Companies. Telephone engineering had waited twenty years for the repeater which would make possible genuine long

(*Continued on page 617*)



An Unusual Demonstration of the "Audion" as a Detector of Radio Currents as Given in Court by Dr. de Forest. All Three Filament Electrodes Were Heated; Figs. 1 and 2 Show How the Three Incandescent Electrodes Were Transposed in the Circuit; F Serving as "Filament," G the Grid and W the Wing.

†Written exclusively for The Electrical Experimenter.

*See paper on "The Audion" Amer. Inst. Elec. Engineers, Oct., 1906.

Efficient and Economical Method of Utilizing the Armstrong Regenerative Audion System for Damped and Undamped Waves

By Samuel Curtiss, Jr.

BEFORE going into detail regarding this arrangement, the reader should be given to understand that the accomplishments made possible by use of same can be duplicated without the use of the transfer switch. In doing this, however, the use of additional instruments is required, such as extra condensers, a second Audion cabinet, or additional inductances. The writer, having taken into consideration the fact that most experimenters obtain their apparatus with some difficulty, and have to make what they have, "go" its limit in accomplishing the desired results, has designed this system with this very view in mind. It can readily be seen that only two variable condensers are used, whereas at least four would be required in the same hook-up without the transferring arrangement. The same idea applies to the Audion, telephones, batteries, etc. If it were desired to transfer from one set to the other by the mere throw-over of the antenna, it is evident that, unless time were taken to change connections, it would require such additional instruments as I have mentioned.

The apparatus used in making up this system is very inexpensive and a large part of the material is usually found in the average experimenter's workshop or about his present receiving set. The transfer switch, for instance, may be a small three-pole, double-throw knife switch which costs between fifty and sixty cents. The inductances, outside of the loose coupler in set "B" can be wound in a couple of hours, and the loose coupler in set "A" need not be an elaborate affair so long as it possesses sufficient self inductance and a wide range of coupling. The Audion bulb need not necessarily be of the most costly type, but can be any one of the tubular Audions. These bulbs give exceptional satisfaction in connection with this system, and if the experimenter should happen to be an owner of a *frozen* bulb, or one that will not oscillate properly, he will find that in most cases it will oscillate with this system. It is only by virtue of the magnetic coupling between the grid and plate circuit that this feat is made possible, as different bulbs have been tried out on other hook-ups and the results could *not* be duplicated.

In regard to the immediate construction of the system, the condensers used are the regular Electro Importing Co., 43 plate variables having an average capacity of .001 microfarad. Such condensers are reasonably cheap in price, and are very efficient for this purpose, as most of the tuning on set "A" is done by inductance, while with set "B" this capacity is very well adaptable to wave lengths of 200-2,500 meters, when used in connection with the usual small loose coupler.

The inductances of set "A" are made up as follows: L1 is the primary loading coil, and is 30 inches long, 6 inches in diameter and wound up to within two inches of each end with No. 20 D.C.C. magnet wire. Ten taps are taken off at even intervals along the coil, and secured to binding posts firmly belted to the tube itself, which may be of fairly thick cardboard. Contact is made with these binding posts by means of a clip having an insulated handle. The loose coupler LC is composed of two cardboard drums twelve inches in length, the outer one being ten inches in diameter and the inner one nine inches. The primary is wound with No. 20 D.C.C. and taps are taken off at every 25 turns, the remaining 25 tapped off singly, in order to secure a fine variation of the inductance. The secondary is also wound with No. 20 D.C.C., but is tapped off at every 30 turns.

The inductance L2 is the secondary loading coil, and also acts as the pick-up coil for the oscillations transferred from the plate circuit of the Audion. It is constructed identically the same as L1, the primary loading coil. The inductance L3 is the driver or "tickler" coil which transmits the plate oscillations back to the grid circuit giving the "regenerative" effect. This coil may be constructed along different lines, but a very efficient one may be made by winding a cardboard tube 6 inches long and five inches in diameter full with No. 20 D.C.C. The coupling may be accomplished by simply placing this coil inside the secondary loading coil. Care should be taken, however, *that the direction of winding is such that it will not buck*, instead of assist, the oscillations of the grid circuit. This can best be determined by first placing the coil L3 inside L2 and reversing the leads of L3 until satisfactory results are obtained.

A few precautionary measures to be followed in constructing this outfit are: in the construction of the loose coupler LC no metal rods should be used for the secondary to slide on as this will cause losses in the circuits. Wooden rods may be used, or the coupling may be varied even without rods i. e., by placing the primary and secondary in inductive relation to each other. For arc signals a rather loose coupling is made possible, and with a set of this description signals have been read with a distance of fully *five feet between the primary and secondary coils.* Care should also be taken that the coils are not shellacked, as such a practice causes hysteresis losses when working with arc signals. If there is danger of the wire coming loose, the coils may be given a thin coating of paraffin.

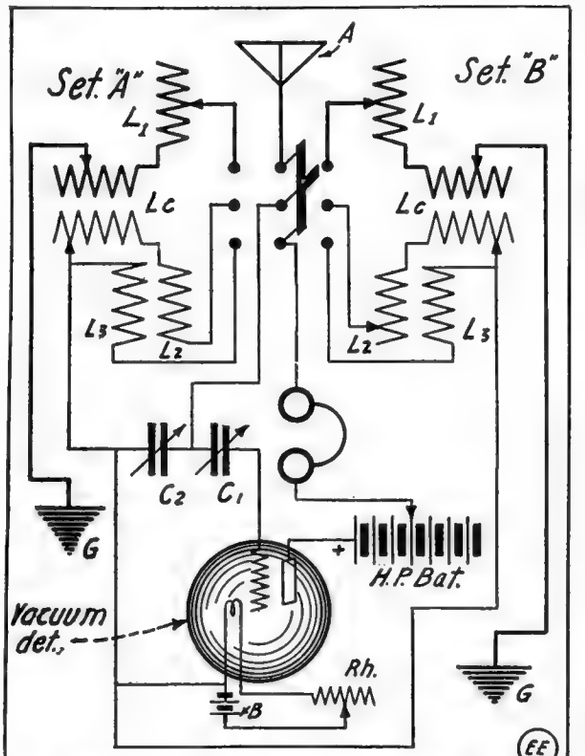
In regard to set "B," the inductance L1 may be a standard loading coil such as put out by the Electro Importing Company, and the loose coupler may be any instrument having a reasonably high wave length for spark signals. An Electro Importing Company *Professional* type loose coupler was used in the tests made with this system, and gave excellent service. The inductance L2 of this circuit is used in connection with L3, and the two should constitute a transformer. The two coils are alike in construction excepting that L2 is tapped for every ten turns. Both coils are 4 inches long, the one with the taps taken off being 4 inches in diameter, and the other one 3½ inches in diameter. These coils should each be wound with 50 turns of No. 22 D.C.C. Relatively close coupling is required between these coils, and when the number of turns is decreased in L2 the coupling should be tightened.

In the operation of set "A" the inductances should be roughly adjusted to a certain wave length and the Audion turned on to ordinary brilliancy. The coupling between L2 and L3 should now be closed up until it is at such a point as to cause a characteristic "plucking" noise in the telephones. The system is now ready for the reception of undamped waves, and by following out the usual method in tuning for these signals, a pure musical note may be obtained of any frequency, in the telephones. Different values of C1 may be necessary to allow the system to properly oscillate.

In the operation of set "B" the usual routine is followed in tuning for spark signals. After the signal has been brought in to maximum audibility the coupling between L2 and L3 is closed to such a point as to amplify the signal without destroying its note. With a little practise excellent results, and really marvelous amplification can be obtained with this outfit.

With an outfit of this kind, used in connection with an antenna 75 feet high and 225 feet long composed of four wires, both Nauen and Eilvese, the German high-powered stations, have been copied thruout the

(*Continued on page 617*)



A Composite Regenerative Audion Receiving Hook-Up Adapted to Spark or Arc Signals at Wave Lengths of from 200 to 13,500 Meters. Requires Minimum of Apparatus and Has Been Tried Out Thoroly.

THE CONSTRUCTOR

A Home-made Lathe for the Amateur

By Alfonso Bolognesi

THE drawings of the lathe here presented show clearly how all the various parts, including the base, are put together and properly aligned.

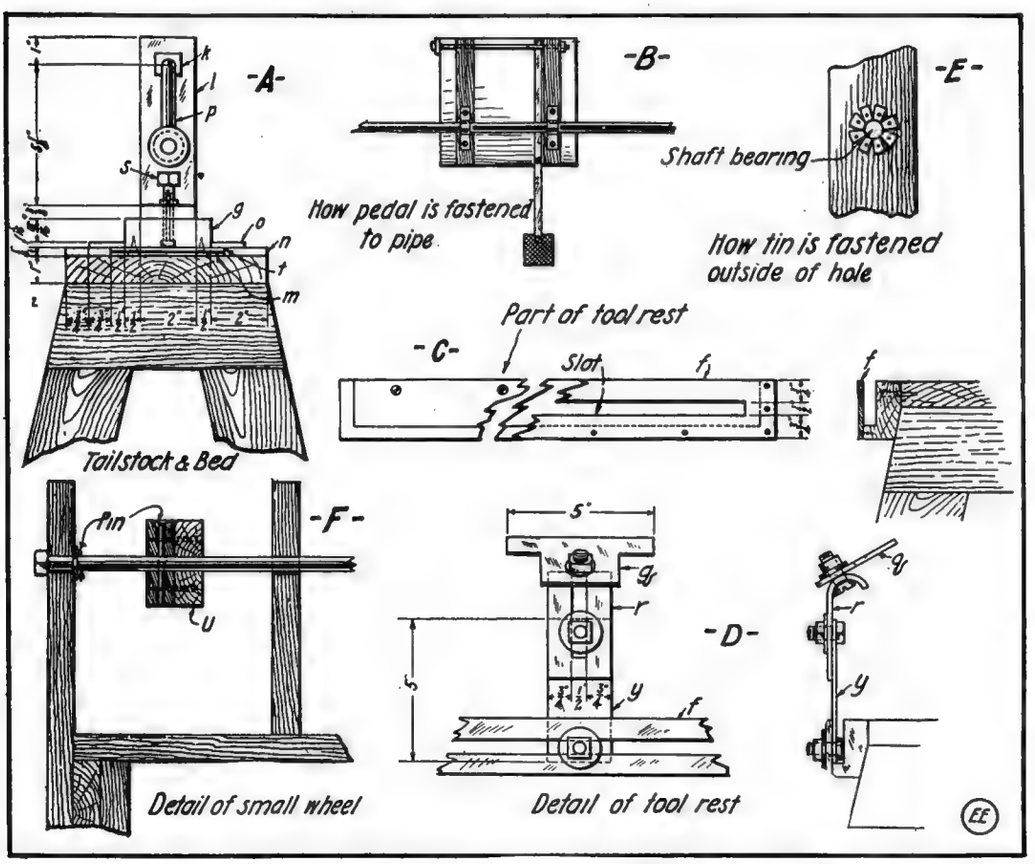
Make the base of the *left end* of the lathe twice as thick by nailing together two of the 3-inch wide pieces as shown in the drawing, so that it can support the weight and strain of the large wheel. Do the same with the axle of the pedal.

For the axle of the large wheel and pedal use an iron pipe. At both ends of the pedal's axle bore a hole and pass through it a large nail. Fasten this nail by a pin, so that the pipe cannot turn around and the nail thus fall out. It is better to make the distance between the two holes a little less so that the ends of the lathe will be pulled together, thereby making it firmer; a base strip 1x8 inches at X will strengthen the frame. Use a pipe for the axle of the large wheel, having a thread at one end for a nut. The hole through the three pieces of boards where the axle is fastened should be made as exact as possible. Bore in the pipe on the inside (of the lathe) right next to the boards a hole and pass through it a large nail or pin. This nail is also fastened with double pointed staples. On the outside, the nut is screwed on as tight as possible, making the axle quite solid. Against the nail on the inside place a piece of wood with a hole larger than the pipe. This is to serve as a large washer. Now, next to this piece of wood place two or three iron washers and then the wheel is ready to be put on. Next to the wheel put two or three more washers and lastly the pin.

Make the large and small wheels by screwing together two boards, one having the grain in one direction and the other board with its grain perpendicular to the grain of the first. This gives the wheels a 2-inch thickness. Near the circumference of the larger wheel, nail a heavy piece of iron rather flat, like a flat iron wheel so as to give the wheel greater inertia. The hole in the large wheel where the bolt (to which the rod connecting the pedals) is fastened should be 3 inches from the center of the wheel and a little to the right of a vertical line passing through the center, when the weight is at the bottom as is shown in the drawing of the right end.

Make the bed of the lathe, first by screwing in the middle of the 7-inch wide board, a piece of iron 4 inches wide and 1/16 inch thick, see Fig. A (m), the whole length of the bed or 28 inches long. On both sides of this iron nail a strip of wood 1½ inches wide and ⅛ inch thick (n). On each of these strips fasten a piece of iron 1 inch wide, 1/16 inch thick and 28 inches long (see o). Fasten these strips so that there will be 3 inches between the two and ¾ inch from the outside edge of the strip of wood to the outside end of the strip of iron, Fig. A.

The tailstock is made by bending a piece of iron 10 inches long, 2 inches wide and ⅜ inch thick, at right angles, at a point 6½ inches from one end. (See piece of iron 1, Fig. A.) One inch from the end of the longer piece of the bent iron bore a hole (k), large enough to make the thread for the screw with the handle (p). The thread for p can be made out of any piece of the right size iron, if an ordinary bolt cannot be found long enough. In the center of the shorter arm of the bent iron, another hole is bored large enough so that the thread for bolt s can be made. This shorter arm is next bolted on a piece of hardwood 4 inches long, 3 inches wide and 1 inch thick (see g). The heads of the bolts are countersunk into the bottom of the piece of wood. The hole for the bolt s is continued through the wood. On the bottom of this piece of wood (g) a piece of iron 4 inches long, 4 inches wide and 1/16 inch thick (see t) is screwed on by four screws. The hole of the bolt s is continued through this iron and with a little care the thread can also be made, so that when the bolt s is screwed down it not only holds the tailstock firmly wherever desired, but makes the latter a whole piece (drawing together the 1 inch thick iron and 1/16 inch thick iron). The screw with the handle (p) carries a nut so as to prevent it from becoming loose once tightened. By soldering a washer to the tail-center it prevents the point from going too deeply into the wood.



The Simple Parts Making Up the Amateur's Lathe Described Herewith. It Will Prove Very Useful in Winding Up Coils and Magnets, Building Small Armatures and Light Hand Turning.

Make the tool rest in the following manner: First by cutting out of the middle of a strip of iron 28 inches long, 2 inches wide and 1/16 inch thick, a 24-inch slot ½ inch wide (Fig. C-f). Screw this on to a board placed on the front side of the bed. Then cut a strip of iron (Fig. D-y), 5 inches long, having the same width and thickness as the previous piece and at each end bore a hole, these holes being large enough for an ordinary bolt. After passing the bolt through one end, fasten it to

the first long piece (y). Through the other hole pass another bolt and fasten it to a piece of iron having one end bent (see r). Through any point where it is bent pass another bolt and fasten a piece of iron 5 inches wide having the shape of a "T" with a hole near the base where it is fastened on (see q). This tool rest can either be lowered, moved in one direction or another and the last piece (q) upon which the tool rests, can be placed at any angle desired. The piece r can be omitted by making y longer and bent at one end.

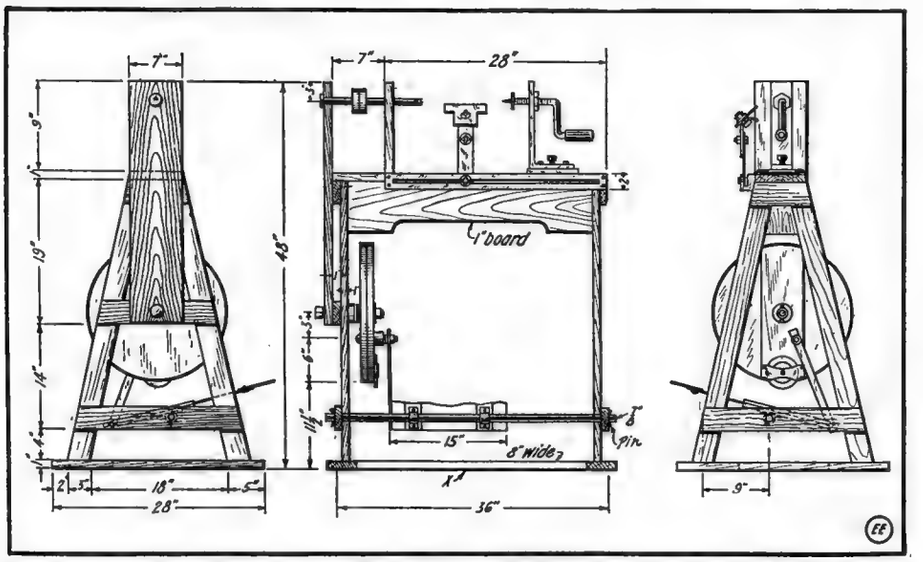
For the pedal see drawing B. Bend two strips of iron into a semi-circle shape and fasten them on to the wood of the pedal. Where the pedal rests on the pipe insert a piece of tin.

The small wheel (see Fig. F-u) which is connected with the large one by a leather belt, should be fastened to its axle by a pin as shown in F.

Where the rod or pipe has to turn in the wood, make the hole a little larger and insert a piece of tin or better brass pipe. Cut the ends of the tin and nail them to the wood as shown in F.

It is a good plan to fasten the lathe to the floor, especially if it is run by a small motor ⅛ to 1/6 horse-power, which is very desirable.

The base of an old sewing machine can be very well used for the base of the lathe. In that case the bed could not rest on the sewing machine but would have to be raised, since sewing machines as a rule are rather low.



The Completed Lathe. It Is Designed to Be Operated by Foot Power, but Can Be Readily Belted Up to a Motor or Engine. About ⅛ to ¼ H. P. Will Drive It Nicely for Ordinary Work.

OPERATING HINTS FOR ELECTRICIANS.

HOT BEARINGS can generally be traced to the following causes: excessive belt tension, failure of oil rings to revolve with the shaft, rough bearing surfaces, bent shaft, poor grade of and too little oil, also end-thrust due to improper levelling. In case of hot bearings apply heavy lubricants and if necessary shut down the machine, keeping the armature running slowly, if possible, to prevent sticking.

TURNING COMMUTATORS at a speed of 500 to 600 feet per minute will be found to give the best results. A diamond point tool, set with its cutting face at right angles, gives the smoothest surface. Finish with fine sand paper.

TO CUT OUT A DAMAGED ARMATURE COIL disconnect the coil from the commutator and after cutting off the leads insulate the exposed ends with tape; then connect the commutator bars corresponding to the leads from the defective coil, by means of a piece of wire about the size of the old coil wire. This piece of wire is commonly known as a *jumper*.

Contributed by
FREDERICK A. GROHSMEYER.

CEMENTING BRASS TO PORCELAIN.

Use thoroughly dry litharge and pure glycerine. To avoid trouble see that no water is in the glycerine or the litharge damp. If the litharge or glycerine contains water it should be carefully dried at a low temperature and the glycerine heated over a slow flame until the water is driven off. The litharge and glycerine should then be thoroughly mixed, using as little glycerine as possible. After this preparation has been applied it requires five to seven hours to dry.

Contributed by DAVID KARRON.

ELECTROLYTIC RECTIFIERS AND HOW THEY WORK

While many experimenters utilize electrolytic rectifiers in their daily work, the theory upon which they operate is not always clearly understood.

At Fig. 1, an oscillographic curve is given, showing how half waves or loops of alternating current are rectified or swung in a common direction with regard to polarity and the (left to right) time axis. In other words, if every other loop of current, as shown in Fig. 1, was drawn on the upper side of the time axis or zero line of potential, then we would have the original alternating current wave form as before rectification.

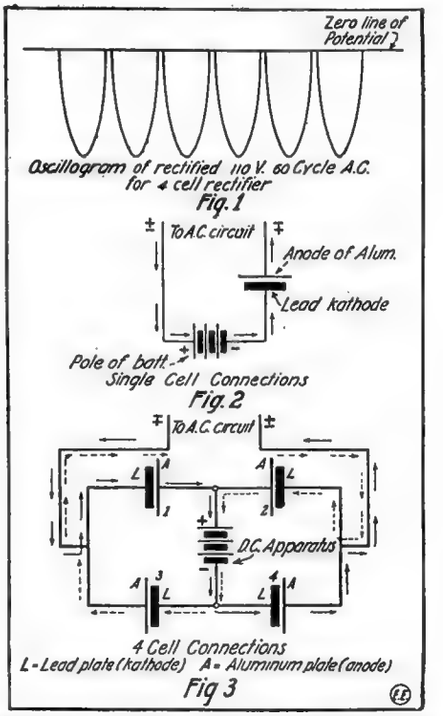
At Fig. 2, there is shown schematically the action occurring in the single aluminum-lead electrolytic rectifier cell. These cells usually contain a saturated solution of bicarbonate of soda. About the best electrolyte ever discovered for use in such rectifiers is one of ammonium phosphate; although a solution of sodium phosphate is very efficacious for this purpose. When A. C. is applied to a circuit such as that shown at Fig. 2, the rectifier cell acts in such a manner as to allow the current to pass in one direction only, viz, from the lead cathode to the aluminum anode. When the current reverses and tries to pass from the aluminum to the lead, through the solution in the cell, it cannot do so, owing to a film of finely divided gas particles which congregate on the aluminum electrode; thus the half waves or loops of current in one direction are clipped off, while those half loops of opposite polarity are allowed to pass. The result is similar to that shown in Fig. 1, excepting that with a single cell rectifier, only one-half the energy in the alternating current is made available in the form of direct current with which to charge a storage battery or other device.

The best form of rectifier to realize high efficiency is the one having three electrodes, or better still, a rectifier composed of four individual, aluminum-lead cells, as outlined in Fig. 3.

The arrows clearly elucidate just how the current passes through the circuit at different intervals. The full-line arrow indicates the passage of current for one-half cycle, and the dotted line arrow the passage of current through the rectifier cells and direct current apparatus for the second half cycle.

An oscillogram curve from such a rectifier will resemble that reproduced at Fig. 1, i. e., the pulses of current will be close together; or in other words, both halves of the alternating current cycle have been rectified. Thus the most efficient type of rectifier is that just described. The usual capacity of a small, glass jar rectifier unit, is about 1½ amperes. However, if four such cells are hooked up as at Fig. 3, about three amperes direct current may be realized when 110-volt, 60-cycle A. C. supplies the circuit. A suitable resistance such as lamp bank, or water rheostat, etc., is invariably required in series with the alternating current mains to control the current passing.

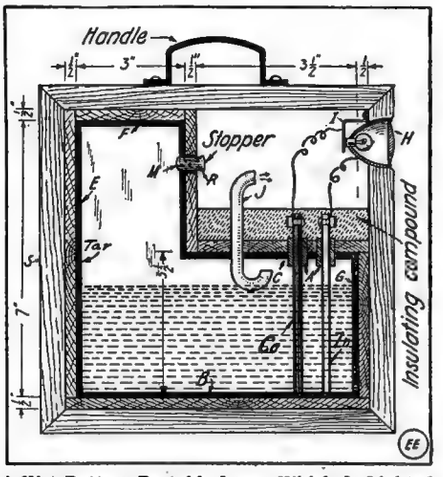
Such rectifiers have been built for charging storage batteries in quite large sizes. The greater the area and number of plates, the greater the direct current available and vice versa; about 10 amperes per square foot of active electrode surface is usually allowed in designing them. In some designs a compact group of plates is used, the lead (or iron) plates being staggered in between aluminum ones, with about ⅛" between adjacent surfaces for the electrolyte. An X-ray machine is built, employing a rectifier of this type, in which case 5 K.W. of A. C. is taken in at 110 volts potential and after being rectified and transformed, it issues at 80,000 volts (unidirectional) direct current.



Showing the Various Actions Taking Place in the Circuits of an Electrolytic Rectifier.

A "Switchless," Portable Battery Lamp

THE illustrations herewith serve to show the details of construction for a unique portable battery lamp requiring no switch to throw the lamp in or out.



A Wet-Battery Portable Lamp Which Is Lighted by Placing the Case in the Position Shown. To Open the Lamp Circuit Turn it Over on Its Side.

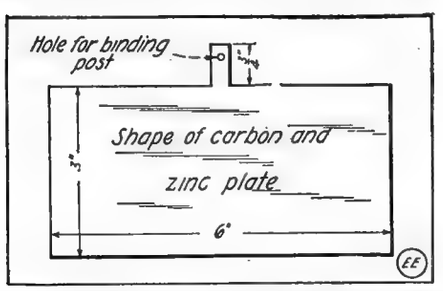
This result is obtained by employing a specially designed battery jar so that the electrolyte can act upon the electrodes only, whenever the lamp is placed in a certain position so as to be lighted.

The first thing to be considered is the container, which is preferably made entirely of ¾-inch oak or white wood. Each side, which measures 9x9 inches square, must be thoroughly sandpapered, and put together with glue and flat-head wood screws. About four screws should be used and these can be either of brass or iron although the former produce a much neater job in the end.

The container consists of eight strips of white wood. Below are the dimensions of each of the various pieces:

B—7"x7 "x½"
C—7"x4 "x½"
D—7"x3½"x½"
E—7"x7 "x½"
F—7"x3 "x½"
G—7"x3½"x½"

The two sides are of the same size, and are to be cut to the shape of the jar when completely assembled. The corners must be very carefully glued with a liquid glue and for the purpose of keeping the parts in substantial position, ⅞-inch flat head iron screws are used. Two holes are bored in cover C, the distance between them being one inch, and that between the inner hole and the end of the case also being one inch, as indicated in illustration. Two pieces of soft rubber tubing, A (old rubber hose), each one inch long, are to be inserted snugly into the holes of the cover. A third hole, about one-half inch in diameter, is now bored one inch from the second. A glass tube J is also to be inserted in this with the ends bent as shown in the illustration. This is done to permit the gas generated by the battery to escape through the tube when it is in use.



Showing Shape of Zinc and Carbon Plates Used in "Switchless" Battery Lamp.

The next, and perhaps the most important step, to be taken in the construction of the portable battery lamp, is to seal up the battery jar so as to make it absolutely acid-proof. To prevent the acid from leaking out of the jar the cracks can be filled up by applying a thin coat of molten pitch or asphalt around the inside walls of the jar, as indicated by the heavy black line. This can be done very well by melting a few pounds of asphalt in a kettle and pouring a small quantity through the rubber tube holes at A, tilting the whole case so that it will run into all the corners; then permit it to cool. Additional molten tar is added until every crevice and surface of the interior is thoroughly coated with the insulating and acid-proof material. The battery plates consist of a carbon and zinc electrode, each measuring 6x3x3/16 inches. On each lug of the plates a hole is drilled large enough to permit an 8-32 binding post screw to pass as shown. Now by lifting the lid of the outer case sufficient insulating compound is poured on top of the plates and over the binding posts to completely cover same.

It must be understood that one of the battery jar sides is not to be secured in place until the plates are first put into position. In order to produce a complete joint when putting this side in place, it should be coated with the pitch while exposed and warmed when closed.

The electrolyte for the battery consists of a mixture of one part of potassium bichromate to three parts of concentrated sulfuric acid and ten parts of water. In order to fill the bottom chamber up to the height of the electrodes a sufficient amount of this solution is used, by pouring through hole M, closed by stopper R. The lighting unit consists of a 2 volt incandescent electric lamp enclosed in a metallic reflector H, the opening of which is closed with a condensing lens. The dimensions of this is subject to your choice and the size of the hole in the frame depends of course upon the size of the reflector.

In order to make contact with the central terminal of the lamp (see illustration) a short brass or copper strip I is fastened as shown. The other connection is made from the reflector. The connections are made with flexible conductors. In order to light the lamp the position of the container must be such that the solution covers the entire surface of the electrodes as shown in the diagram. When the light is to be extinguished all that is necessary is to turn the cabinet on its side S in such a manner as to cause the acid to enter the upper compartment, thus freeing the plates from the solution.

This is the way in which the lamp can be lighted and extinguished without a switch, at the same time preventing the zinc plates from being eaten away by the acid when it is not in use.

A SIMPLE STEP-DOWN TRANSFORMER.

A step-down transformer for reducing 110 volt A.C. Current where a low voltage is required for experimental purposes, may be made at a low cost in the following manner:

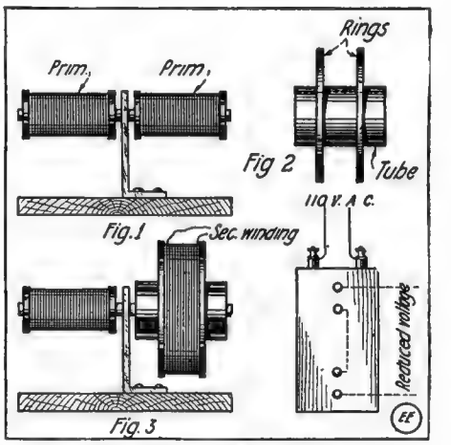
Procure a pair of high resistance (about 80 ohms) electro-magnets, similar to those used in telephone boxes for operating the bell. One end of the core of each magnet is drilled and tapped for a machine screw of standard size. Take a machine screw of about one inch length and cut the head off; next get a strip of brass 3 inches long, ½ inch wide, and ⅛ inch thick. Bend this strip at right angles ¾ inch from the end. Drill a 5/32 inch hole ¼ inch from the long end of the strip; on the short end of the strip drill two holes for fastening the strip to the case.

Insert the machine screw about half its length into one of the magnets then slip the strip of brass, just described, over the screw and screw the other magnet down on top of this. This will be the primary of the transformer, and should be mounted in the bottom of a cigar box. (Fig. 1 shows the primary of transformer as just described.) It is preferable to make the magnet cores of soft iron wire.

Connect the two magnets in series and fasten the two remaining wires to binding posts in the end of the cigar box.

The secondary of the transformer is even more simple in construction:

Take a strip of stiff writing paper and wrap it around one of the magnets making a tube about ⅛ inch in thickness that will fit flush over the flange at the ends of the magnet; dip this tube in paraffine to stiffen it. Then make two cardboard rings that will fit snugly over the tube just made, and place these rings about 1½ inches apart and dip the whole in paraffine to steady them. (See Fig. 2.)



If You Have a Pair of 80 or 100 Ohm Electro-Magnets Lying Around, You Can Readily Construct an A. C. Transformer for Experimental Work.

Next procure 30 feet of No. 24 B.&S. gauge copper, cotton-covered magnet wire, or a size as near that as possible, and wind it all *evenly* in the space between the two rings. This completed constitutes the secondary of the transformer which should be slipped over the electro-magnet and the two leads of the secondary winding made fast to two binding posts placed in the top of the cigar box.

The voltage of this transformer may be doubled by making another secondary similar to the one just described and placing it on the other magnet in the same manner and fastening its leads to two more binding posts in the top of the box, thus making two separate secondary outlets; and the two secondaries may be connected in series to double the voltage. (Fig. 3 shows the completed transformer and connections.)

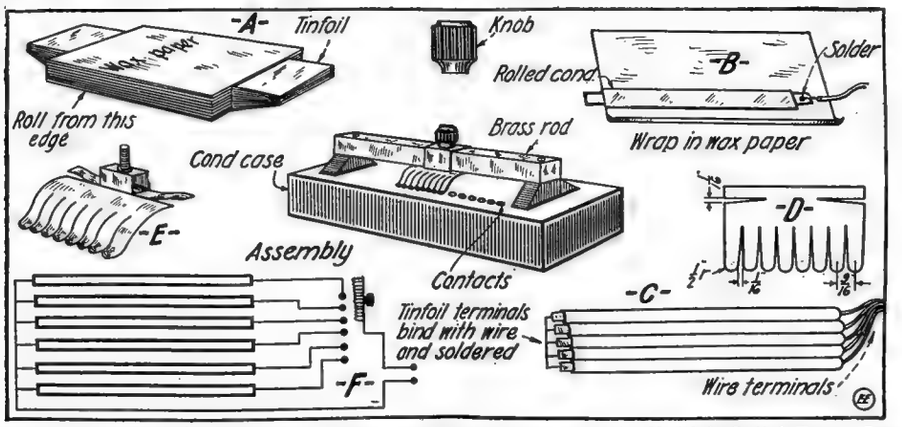
If these instructions are followed a serviceable experimental transformer can be built at a very small cost. The writer is using a similar one now which he made and it is giving excellent results.

Contributed by

WILLIAM P. McWHORTER.

AN ADJUSTABLE FIXED CONDENSER.

Many of the prominent wireless companies are now listing a fixed condenser which may be adjusted to variable capacities. The following described condenser is adjustable to a number of capacities and



Details and Assembly of an Efficient, Adjustable, Fixed Condenser of the Multiple Switch Type. Can Be Made in Any Desired Size.

in case of necessity may be used in the place of a variable condenser.

Obtain some tinfoil and wax paper. Cut 33 pieces of the wax paper 3 inches by 3 inches and 8 pieces of 4½ inches by 4½ inches. Cut 26 pieces of tinfoil 2 inches by 3 inches. Make one condenser of 5 pieces of tinfoil and seven of 3 pieces each. These units are assembled by laying one of the small pieces of wax paper on it, and so on. The tinfoil is to protrude ½ inch on either side. Then roll the condenser from one side, as indicated at sketch A. This rolling has two advantages: first, compactness; second, on account of the thickness of tinfoil presented it is easy to solder. Bind the rolled condenser and then solder the wire to one of the tinfoil lugs. Next wrap the condenser in one of the large pieces of wax paper, as indicated at Fig. B, leaving one of the lugs unwrapped. Then bind the unwrapped lugs together with a wire and solder a lead to them.

The next problem is to build a suitable switch. The blade is of spring sheet brass, cut as shown at D. A few suggestive dimensions are given, but the size of the switch will depend upon the contacts used. This switch is soldered to the bottom of a square brass tube as shown. A battery terminal such as used on the positive electrode of the Ever-ready type of dry cell is soldered to the top of the slider tube. A round "Perkins" sn..p switch knob is then screwed on and the sliding element is complete. This is shown at Fig. E. The stationary slider element is a ¼x¼-inch brass rod.

A wooden case is then built of the correct size to contain all the condenser units. Suitable binding posts and contacts are mounted on the cabinet and the slider rod is mounted on wooden blocks, as indicated in the assembled view.

A condenser such as that described has so many capacities that it may be used in emergency as a variable condenser substitute. While it does not have the advantage of air dielectric, it will serve the purpose very well. The hook-up is shown at Fig. F for the uninitiated. Contributed by

RAYMOND SUTCLIFFE.

PLATING HINTS.

The usual nickel-plating solution is composed of double nickel-ammonium sulphate three parts, ammonium carbonate three parts, and water one hundred parts. Another good formula is composed of nickel sulphate, nitrate, or chloride, one part; sodium bisulphate one part, and water twenty parts.

Nickel anodes are used in the bath to maintain the strength and great care must be taken to have the bath perfectly balanced, that is, not too acid nor too alkaline.

To test this, have handy some blue-and-red litmus paper. If the blue paper is dipped in acid solution, it will turn red, and back to blue again if placed in an alkaline solution. If the nickel solution is too strong with alkali, a trifle more of the nickel salts must be added, so that both the red and blue litmus paper, when dipped in the liquid will not change color. If the bath is too alkaline, it will give a disagreeable, yellowish color to the deposit of metal on the kathode and if too strong in acid, the metal will not adhere properly to the kathode, and will strip, peel or blister off.

Contributed by

WILLIAM WILLIAMS.

HOW TO BUILD AN ELECTRICAL THERMOMETER.

The operation of the resistance thermometer depends upon the change in resistance of a conductor with a change in temperature. The ratio of resistance to temperature is constant for ordinary atmospheric temperatures, so that it is not at all difficult to calibrate the resistance of a conductor in terms of temperature. In this apparatus, a movable coil, wound with fine copper wire, is changed in resistance by the atmosphere. The coils of the bridge, however, are wound with manganin wire, which has a very constant temperature coefficient.

The base of the electrical thermometer is 3½ feet long by eight inches wide. On this are mounted the six binding posts, B_1, B_2, B_3, B_4, B_5, B_6, the known resistance R, the slide wire and the slider, S, which indicates the temperature on the scale. For the slide wire and known resistance, number 30 S.C.C. manganin wire is used. The slide wire is fastened beneath the binding post B_1, then under the brass clamp C, to the other clamp at the right, and finally to binding post B_6. Parallel to the wire a square brass rod is arranged, one end of which is connected to post B_3. The slider should have a rather sharp contact against the wire to give the most accurate reading. A scale of cardboard or celluloid is fastened at the opposite side of the wire. This scale is to be calibrated to give Centigrade or Fahrenheit readings.

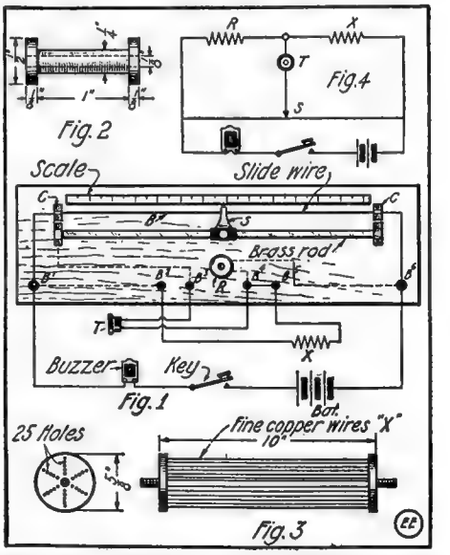
About fifteen feet of number 24 manganin wire are required for the known resistance R. However, the resistance of the different conductors may vary slightly, so that the wire should not be fastened permanently until the bridge is completed, and the circuits tested. Otherwise, the resistance of the spool might be such that a balance with the unknown resistance would not be found on the slide wire. The wire should be wound non-inductively, either by winding it double, or reversing the direction when half the wire is on the spool. Fig. 2 gives the dimensions for the spool. The ends of the coil are connected to posts B_4 and B_6.

Fig. 3 gives the dimensions for the temperature coil frame X. This has about twenty-five holes drilled in the hard rubber end pieces. No. 40 single cotton-covered copper wire is run back and forth between the end pieces, through the holes. To protect the wires, the coil is encased in a brass tube, having a number of holes drilled in it. This allows the air in the tube to change in accordance with the air in the room. Flexible leads are brought from the coil to the bridge, long enough for the work to which the instrument is to be put. The leads run to posts B_2 and B_3.

When connection is made between B_1 and B_2, and between B_4 and B_5, the electrical thermometer is ready to be connected with the receiver T, and the buzzer circuit. To test the instrument, the key is pressed, and the response from the buzzer noted in the 'phone. Slider S is then moved until the sound is at a minimum. This shows that the resistances of R and X, as represented in the elementary diagram, Fig. 4, have been balanced by means of the slider S. A change in the temperature and a resulting change in the resistance of X, however, requires a different adjustment for the slider. Thus it is that the bridge can give temperature readings directly.

The calibration of the apparatus is the last step. This is done by immersing the coil X in oil. A balance is obtained on the slide wire, and the temperature of the oil taken by means of a good thermometer. Then the reading is recorded on the scale. Several readings are taken in a similar manner with the oil at different temperatures. Intermediate readings can be readily laid off.

Aside from the enjoyment that an experimenter takes in building apparatus, there are several practical applications for this instrument. By means of the electrical thermometer temperatures can be read at considerable distances from the room under test. By substituting a galvanometer for the telephone receiver, and a steady current for the buzzer circuit, a slight change in the temperature of a heat-treating room, drying racks or incubator can be detected



Parts and Assembled View of Electrical Thermometer.

by an alarm circuit on the galvanometer. Where the temperature coil is quite far away the leads should be heavy.

HOW TO MAKE IT

This department will award the following monthly prizes: **First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.**
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of **$3.00** is awarded; for the second best idea a **$2.00** prize, and for the third best a prize of **$1.00.** The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

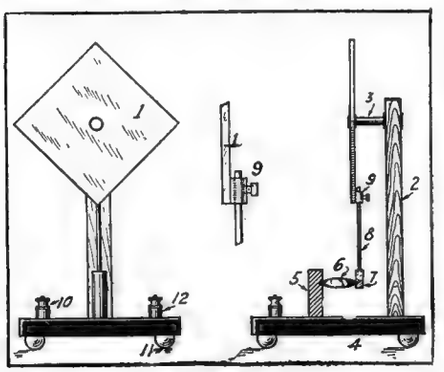
A SOUNDING BOARD MICROPHONE.

The microphone here shown is twice as efficient, I believe, when properly constructed, compared to the ordinary type, as it employs two sounding boards instead of the customary single one. The wooden base acts as one diaphragm and the sounding board, 1, as the other.

The diaphragm, 1, was made from the side of an egg-box cut down to measure six inches square. It was fastened to the wooden upright, 2, by a brass rod, 5/32 of an inch in diameter and four lock-nuts, shown in the drawing at 3. The upright, 2, was fastened to the base, 4, by means of a wood-screw and glue.

A piece of carbon, 5, which may be obtained from an old dry cell, was cut to 1½ inches long. A small, conical indentation was drilled into this piece about ⅜ of an inch from the top. The second piece of carbon, 6, which was obtained from a lead pencil, should be about ⅛ of an inch in diameter and about 1½ inches in length, with both ends pointed as per illustration. Piece 7 is cut from the piece left over in making rod, 5, and is fastened to the brass rod, 8, by means of a threaded hole as indicated. This rod, 8, was fastened to the diaphragm by means of a small block of wood, 9, glued to it, having a hole drilled through the center. Into the hole the rod was inserted, glued and held by a small set screw. The battery from which the carbon was obtained also furnished the binding posts—10 and 12. Connections were made by attaching a wire from brass rod, 8, running it down the upright to binding post, 10, while the carbon post, 5, was connected with binding post, 12. With the addition of four small feet at the corners, shown at 11, in the drawing, and a coat of shellac the instrument was ready for use.

With the microphone described herewith, connected with an ordinary 75 ohm telephone receiver, and three batteries and



Experimental Microphone Capable of Being Made Extremely Sensitive. Utilizes a Sound Detecting Diaphragm Made of Wood.

placed in a room, speech from any part of the room was heard with startling loudness and clearness.

Contributed by LEN K. WRIGHT.

[*This design provides plenty of opportunity for experiment and the board, 1, may and has been made quite thick and also larger in some commercial designs.—Ed.*]

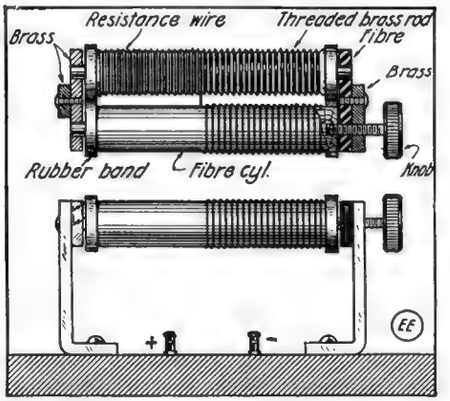
SECOND PRIZE, $2.00

RHEOSTAT WITH PRECISION ADJUSTMENT

The accompanying illustration, I think, is self explanatory, but for those readers who care to make this rheostat and do not quite grasp the idea, I will go into a little detail on it.

Procure the following material, (size to suit constructor): one piece threaded brass rod or a large brass machine screw, one piece fiber or hard rubber rod, one typewriter knob, four screws, two pieces of brass for uprights, one piece of brass for yoke, one piece of fiber or hard rubber for opposite yoke, two small pieces of leather or flat rubber band, one piece of wood for base, two binding posts and a piece of resistance wire.

On each end of the brass and fiber rods glue the rubber band or leather strip. This is to make the brass rod revolve when the fiber rod is turned (by friction). Solder one end of wire to brass rod and wind rod full between the threads, leaving enough to connect to the brass screw in typewriter



A Finely Adjustable Rheostat in which the Wire Is Wound On or Off a Threaded Metal Cylinder from a Fiber One.

knob. The fiber yoke must be on same side as typewriter knob as this prevents short-c cuiting the wire. Be sure to have the screw of typewriter knob go through the brass upright and fit snug as this completes the connection to binding-post.

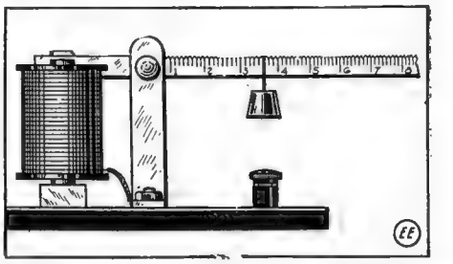
I think the rest will be clear from the illustration. Turning the knob to right, winds the resistance wire on the fiber rod, thus increasing the resistance of the rheostat, etc. You can see at a glance what a fine adjustment can be obtained from this instrument, finer than any rheostat ordinarily made. It's a classy little instrument if the maker will have a little patience in building it.

Contributed by JAMES G. FITCHETT.

THIRD PRIZE, $1.00

A QUICKLY CONSTRUCTED BATTERY GAGE.

I submit herewith a plan for a battery gauge which, while not giving the exact volts or amperes will roughly indicate the amount of energy left in a cell. The cell



A Battery Gage that Is Simplicity Itself. The Further Out the Weight Is, the Stronger the Battery Exciting the Magnet.

is connected to two binding posts and the current goes through the coils which pulls down the armature. The weight can then be adjusted until the coils will no longer pull down the armature. The reading can then be taken from the scale.

Contributed by J. L. GLATHART.

CUTTING GOLD LEAF.

Experimenters in the domain of static electricity frequently have occasion to cut narrow strips of gold, silver, or aluminum foil for use in numerous experiments and in the construction of detecting and measuring instruments. Very few of the leaves are obtained without kinks and notches. The difficulty can be overcome in a very simple manner. Place the leaf between two pieces of smooth writing paper and cut paper and leaf together with a very sharp pair of scissors. As the metal generally adheres to the cut edges of the paper there will still be a difficulty in separating it unless the following simple expedient is adopted. Lay the strips on a warm flat surface and cover with a piece of writing paper that has been well warmed before a fire. Hold this at one side and pass one hand lightly across the paper, thus giving it a small electric charge. Upon lifting the paper the foil will be found adhering to it, and can be removed without difficulty upon cooling.

INK POWDER.

A good ink powder to be thinned with water can be made from the following: Malachite Green Crystals, one part; Fuchsine, one part; Lump Gum Arabic, one part. The Gum Arabic should be partly pulverized.

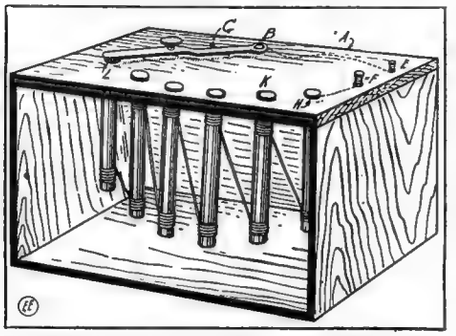
METAL POLISH.

Fusorial Earth, ½ lb.; Paraffin Wax, 1 oz.; Lubricating Oil, 3 oz.; Oelic Acid, ½ oz.; Oil of Mirbane, ½ dram. Melt the *Paraffin* with the *Lubricating Oil* and work in the powdered *Fusorial Earth.* Then add the *Oelic Acid* and mix thoroughly. Lastly add the *Oil of Mirbane.*

Contributed by MERLE NANTZ.

A CARBON ROD RHEOSTAT.

The boy who has a little time can make a rheostat at very small expense to regulate his small toy electric motor. The rheostat here described is easy to make and well worth the effort. Its capacity can be



The Experimenter Will Find this Carbon Rod Rheostat Extremely Serviceable.

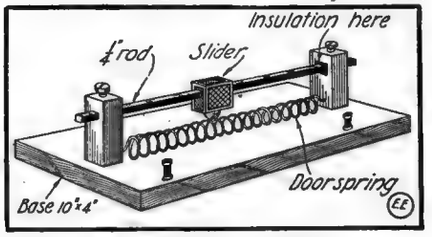
enlarged by increasing the number of carbons, but for the average small motor, six discarded arc lamp carbons will generally suffice.

First procure a piece of clear pine or other soft wood measuring 8 inches long, 6 inches wide and ½ inch thick; this is shown at A. Draw a line parallel with the ends, one inch from the top of A and mark a point B, to set your compass on. Now with the compass points set 4 inches apart draw part of a circle. Bore six holes 1½ inches apart on this line. Bore the holes the size of the carbon you can procure.

For the carbons you can use those found in batteries or obtain a few from the lampman when he removes the carbons from the street arc lights. Cut them about 5 inches long, for that length is sufficient. Now insert the carbons in the holes you have bored, so that about ¼ inch or ⅜ inch projects above the top of the box A. Turn the piece over and pour melted sealing wax or paraffin around the holes to hold the carbons in place. Next obtain a piece of brass G, about 4 inches long and ½ inch wide and drill a 5/32 hole in it. Then secure a ⅛ inch bolt and nut and attach it on the board as shown. On the other end mount a small knob from an old kettle lid. Two binding posts from old batteries are all right. Put these on each corner of the board at E and F. Connect the brass blade G to E with No. 16 insulated wire and use similar wire to connect H with F. H is the carbon underneath the board. Connect the carbon H with K and so on using the same size wire. Scrape off all the insulation where it is wound around the carbon and solder it

A SIMPLE RHEOSTAT.

The illustration accompanying this article shows a simple rheostat which the writer made very cheaply from a door spring, four binding posts and a slider with rod to fit. The door spring can be of any desired



A Rheostat Made from A Door Spring and a Slider.

length, but the size indicated proved the most successful. A close study of the illustration will show how it is made. The insulation was made from cardboard.

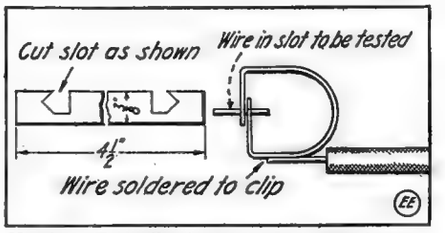
Contributed by MORRIS ZUY.

with soft solder. Next make a box measuring 8 inches wide and 6 inches deep. This will protect the carbons and hold the cover A. Connect a wire from the battery to the terminal E, then connect the other terminal F to the board A to the motor, and next the battery to the motor. The motor will run fastest when the lever G is on the carbon H and slowest when on carbon L.

Contributed by ELMER YEACK.

HOME-MADE TESTING CLIPS.

A simple testing clip can be made from a strip of phosphor-bronze No. 22 B. & S. gauge, by cutting off a length 4½" and ⅜" wide. The slots are cut the same on both ends as shown in the development sketch. After doing this, bend as in the upper



Here's a Test-clip Anyone Can Make from a Strip of Brass or Bronze.

illustration of Fig., and solder a wire on the clip.

When the clip is pressed together with the fingers the wire is disconnected. When released it will hold the wire firmly in the jaw, making a good connection.

Contributed by FRANK HARAZIM.

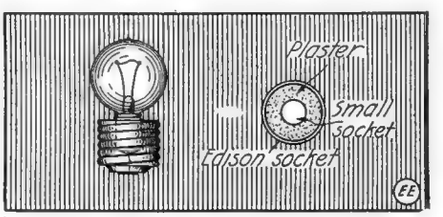
TO CLEAN BRASSWARE.

Mix one ounce of oxalic acid, six ounces of rotten stone, in a powder, one ounce of sweet oil and enough water to make a paste. Apply a small amount and rub dry with a flannel. This is much better than most of the polishes, as it will not corrode the brass as do polishes that contain nitric or other acids.

CANDELABRA ADAPTER.

To make an adapter, for reducing the Edison-base down to a miniature or candelabra size, procure an old burned-out Edison-base lamp and break the globe, leaving only the brass base.

From a miniature or candelabra Christmas tree socket, take out the brass threaded part. That is the vital part of the socket. It will be found that the Edison-base will have the old wire still soldered to it; leave it so, and proceed to solder



Simple Manner of Converting Miniature Base Lamp to Candelabra Style.

the free ends to one of the small sockets.

Having done this, fill the large base with moistened plaster of paris, and sink the small lamp base into the plaster until it is level. Be careful not to break or short-circuit the connections while doing this. Allow to dry and the adapter is ready for use.

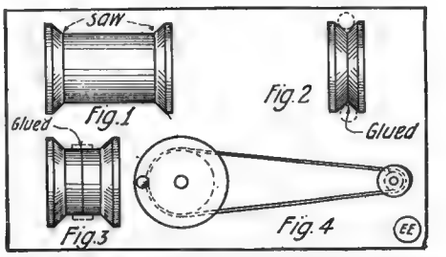
Contributed by MARSHALL CREE.

SUBSTITUTE FOR GOLD.

A substitute for gold is obtained by combining 94 parts of copper with 6 parts of antimony and adding a little magnesium carbonate to increase the weight. It is said that this alloy can be drawn, wrought and soldered very much like gold, and that it also takes and retains a gold polish. It is worth 25 cents a pound.

SIMPLE STATIC MACHINE SPINDLE.

The upper spindle for a high-speed stat-



How to Make Effective Belt Pulleys for Static Machines from Common Thread Spools.

ic induction machine like the Whimshurst can be very easily made by sawing or cutting off the ends of an ordinary thread spool and then gluing them together as shown in Fig. 2. If a flat belt is to be used instead of a cord then the spindle should be similar to Fig. 3.

Contributed by JOHN T. DWYER.

LOCATING A GROUND BY VOLTMETER.

The distance to a ground can be determined only approximately by means of a voltmeter, and then only when the resistance at the ground is negligible compared with the resistance of the bad wire from the testing end to the ground. To estimate the distance to the ground, connect the voltmeter across the terminals of a suitable battery and call the reading d. Then connect the same battery and voltmeter in series with the line to be tested and the ground, thus forming a circuit through the battery, voltmeter, line, and ground. Let the voltmeter reading be d^1. Then, if r is the resistance of the voltmeter, the resistance of the circuit is

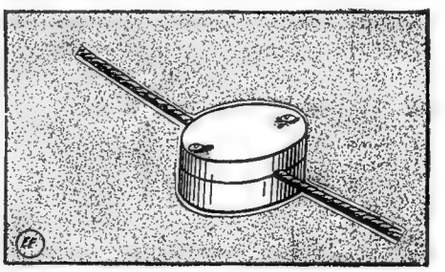
$$(a) \qquad R = r\left(\frac{d}{d^1} - 1\right)$$

This is the same formula used in determining the insulation resistance of a line. Since the line is grounded at some point, R is only larger than r by the resistance of the line, earth return, and ground contacts. Hence, the resistance x to the ground is $R - r$ and is given by the formula:

$$(b) \qquad x = r\left(\frac{d}{d^1} - 2\right)$$

A SUBSTITUTE FOR INSULATING CLEATS.

In wiring up bells, alarms, etc., the use of common felt gun wads makes a very good cleat for the wires. They are used as illustrated. The insulated wire is placed



Using Felt Pads from Shot-gun Shells as "Cleats" For Wires.

between two wads and is fastened by two nails or screws.

Contributed by LEWELLYN ABBOTT.

Experimental Chemistry

By Albert W. Wilsdon

Seventh Lesson

HYDROGEN.

HYDROGEN is a colorless, odorless and tasteless gas. It is the lightest of any of the known elements. This gas was discovered by Paracelsus [born near Zurich, Switzerland, 1493—died, 1541], a remarkable alchemist and physician, in the Sixteenth Century by the interaction of acid and metals.

In 1766, Henry Cavendish [born at Nice, 1731—died 1810], discovered the extreme levity of *inflammable air*, which Antoine Laurent Lavoisier, the distinguished French chemist, about 1783 termed Hydrogen, and this name it still retains.

The discovery of Cavendish led to balloon experiments and projects for aerial navigation. Cavendish later discovered that water resulted from the union of two gases, namely—Oxygen and Hydrogen.

Occurrence and Distribution.

UNCOMBINED:—Free hydrogen is present in the gases which escape from volcanoes, natural gas openings, and in coal mines.

COMBINED:—Combined Hydrogen is abundant and widely distributed. It forms 1-9th part by weight, and 2-3rds parts by volume, of water. It is also found in plants and animal tissues, as well as in vegetable matter. It is an essential constituent of all acids, and when combined with carbon, forms many gases and liquids called hydrocarbons, which are used in the manufacture of kerosene naphtha, and illuminating gas. It is also found in carbohydrates, or many vegetable compounds, as, wood, paper, sugar, starch, etc. When combined with nitrogen it forms Ammonia [NH_3]; and when combined with Sulfur, forms Hydrogen Sulfid [H_2S], which is to be found in the free state at many sulfur springs.

Relation to Life.

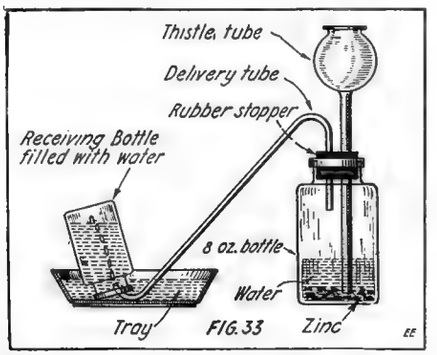
Although hydrogen is not poisonous, it will not support life, or respiration.

Preparation.

Hydrogen, like oxygen, may be prepared from its compounds, by any of the following methods:

1. By the interaction of a metal with an acid. The metals usually employed in the laboratory for this purpose are: Zinc [Zn]; or Iron [Fe]. While the acids usually employed are: Sulfuric or Hydrochloric in dilute solutions.

The reaction which takes place between these acids and metals are as follows:



How the Apparatus Is Set Up for Producing and Collecting "Hydrogen." See Experiment No. 22.

$Zn + 2\,HCl$	=	$ZnCl_2$ Zinc Chlorid	+	H_2
$Zn + H_2SO_4$	=	$ZnSO_4$ Zinc Sulfat	+	H_2
$Fe + 2\,HCl$	=	$FeCl_2$ Ferrous Chlorid	+	H_2
$Fe + H_2SO_4$	=	$FeSO_4$ Ferrous Sulfat	+	H_2

The reaction of Nitric Acid [HNO_3] and Copper [Cu] will not liberate Hydrogen, as can be shown by the equation:

$$\underset{\text{Copper}}{3\,Cu} + \underset{\text{Nitric Acid}}{8\,HNO_3} = \underset{\text{Copper Nitrat}}{3\,Cu(NO_3)_2} + \underset{\text{Water}}{4\,H_2O} + \underset{\text{Nitrogen Monoxid}}{2\,NO}$$

This equation shows that all acids will not react with metals to liberate Hydrogen. In this case Water [H_2O] and Nitrogen Monoxid [NO] was formed in the place of Hydrogen.

2. Hydrogen can also be prepared by the reaction of metallic Sodium [Na] or, metallic Potassium [K] on water, the reaction being:

$$\underset{\text{Sodium [metallic]}}{2\,Na} + \underset{\text{Water}}{2\,H_2O} = \underset{\text{Sodium Hydroxid}}{2\,NaOH} + \underset{\text{Hydrogen}}{H_2}\uparrow$$

$$\underset{\text{Potassium [metallic]}}{2\,K} + \underset{\text{Water}}{2\,H_2O} = \underset{\text{Potassium Hydroxid}}{2\,KOH} + \underset{\text{Hydrogen}}{H_2}$$

3. By the electrolysis of water. The equation for the liberation of hydrogen by the Electrolysis of water is as follows:

$$\underset{\text{Water}}{2\,H_2O} = \underset{\text{Hydrogen}}{2\,H_2} + \underset{\text{Oxygen}}{O_2}$$

4. By passing steam over iron filings, the reaction being:

$$\underset{\text{Iron}}{3\,Fe} + \underset{\text{Water}}{4\,H_2O} = \underset{\text{Ferroso—Ferric Oxid}}{Fe_3O_4} + \underset{\text{Hydrogen}}{8\,H}$$

5. By boiling Zinc in Potassium Hydroxid, the reaction being:

$$2\,KOH + Zn = K_2ZnO_2 + 2\,H$$

Properties.

CHEMICAL:—1. Hydrogen unites with oxygen and many elements directly. Cavendish showed that Hydrogen burning in air formed steam [water].

2. It burns in the air and oxygen with almost an invisible, but very hot flame, the heat given off being as much as five times its weight of coal.

3. It has great affinity for Chlorin [Cl] forming Hydrochloric acid [HCl]; with Fluorin [Fl] forms Hydrofluoric Acid [HFl]; with Bromin [Br] forms Hydrobromic acid [HBr].

4. It indirectly forms hydrocarbons.

5. It is a strong reducing agent.

6. It has no affinity for most metals.

7. It is a non-supporter of ordinary combustion.

8. A mixture of Hydrogen and air, explodes violently when ignited. [Be sure in performing the experiment of collecting this gas by the displacement of water, that NO air is allowed to remain in the bottle.

PHYSICAL:—1. Hydrogen is without odor, color or taste.

2. It is the lightest gas known. One liter at S.T.P. weighs approximately 0.09 gram.

3. It is slightly soluble in water. Two volumes of hydrogen dissolving in one-hundred volumes of water.

4. It is rapidly diffusible.

5. It can be liquefied and solidified, the liquid being 1-14th as dense as water, and is the lightest liquid known.

6. It is not poisonous, but will not support life.

Uses of Hydrogen.

1. For the Oxy-Hydrogen Blowpipe. [See the October, 1916, issue of THE ELECTRICAL EXPERIMENTER for illustrations and descriptions of the apparatus.]

2. The low density permits its use in balloons.

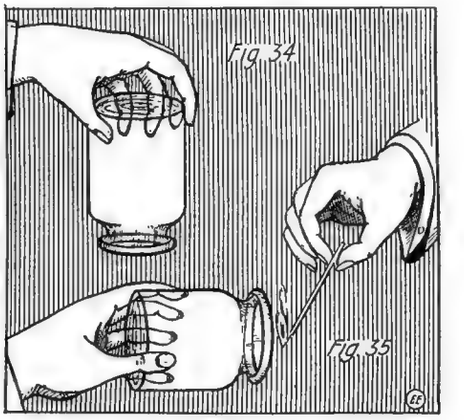
3. It is used as an ingredient in the manufacture of illuminating gas.

4. It is used for high and low temperature thermometers.

5. It is used in the laboratory as a reducing agent.

Experiment No. 22—

Bend a glass tube as shown by Fig. 33.



Bottles Filled with "Hydrogen" Should be Kept Inverted Owing to its Lightness and Tendency to Escape. Lower Figure—Experimenting with a Lighted Splint and "Hydrogen."

[Consult the June, 1916, issue of THE ELECTRICAL EXPERIMENTER for method of bending glass tubing.]

Set up the apparatus shown by Fig. 33, by placing a few pieces of Zinc in the bottle and partially fill it with water as shown. Pass the Thistle tube thru the 2-hole rubber stopper, being sure that both the tube and hole are wet, and insert the tube with a twisting movement, grasping the tube as near the bottom as possible. DO NOT FAIL to take these precautions. Insert the delivery tube in the same manner, as shown by Fig. 33.

Now, after filling two 8-ounce bottles with water as shown by Figs. 28 and 29 November, 1916, issue of THE ELECTRICAL EXPERIMENTER], place them under the water in the tray or basin in the same manner as described for the collection of oxygen in the last installment.

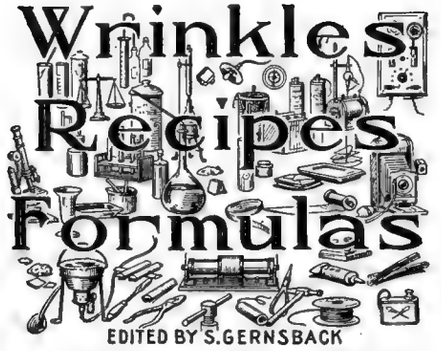
Place the delivery tube under the receiving bottle and collect the gas by adding about 3 c.c. of HCl. to the water thru the Thistle tube. (Reject the first portion of the gas.) As the gas is invisible the indication that the bottle is full is made apparent by the appearance of bubbles of gas around the outside of the receiver. Slip a glass plate [4 x 4 inches] over the mouth of the filled bottle WHILE UNDER WATER and remove. Keep in an inverted position, as shown by Fig. 34, until ready to apply the tests. The reason that the bottle is placed in this position, is on account of the extreme lightness of the gas, which has a very strong tendency to rise. If placed upright as done with the oxygen in the previous experiments, it would be likely to escape from the receiver.

[Note:—If the reaction is not strong enough upon the addition of 3 to 5 c.c. of Hydrochloric acid [HCl], add more acid till the generation takes place with fairly rapid intensity. If the action becomes too strong, add more water, a little at a time, till it decreases.]

Experiment No. 23—

Take a receiver filled with Hydrogen, and hold it in the left hand, *upside down*, as shown by Fig. 34, then apply a lighted splint to the mouth, being careful to keep the fingers holding the splint, near the side of the jar, as shown by Fig. 36. Notice precisely

(*Continued on page 622*)



Under this heading we publish every month useful information in Mechanics, Electricity and Chemistry. We shall be pleased, of course, to have our readers send us any recipes, formulas, wrinkles, new ideas, etc., useful to the experimenter, which will be duly paid for, upon publication, if acceptable.

USEFUL GLASS WORKING FORMULAS.

1. *Glass Polishing Paste.*—Prepared chalk, 9 oz.; white bole, ½ oz.; jewelers' rouge, ½ oz.; water, 5 oz.; alcohol, 3 oz. Mix into a paste. To clean and polish windows or mirrors, moisten a cloth with alcohol, place a quantity of the paste about the size of a bean on the glass and rub over the surface with the cloth until dry and powder is removed.

2. *To Cut Glass Without a Diamond*—Glass may be cut under water with a strong pair of scissors or shears. Mark the part that is to be cut away with a heavy black line, then sink it with one hand under water as deep as you can without interfering with your view of the line and with the other hand use the scissors to cut away the part that is not required.

3. *To Drill Holes in Glass.*—Bank the spot with a wad of putty. Make a hole into the putty down to the glass and of the size wanted. Into this pour melted lead and the piece will drop out.

4. *To Engrave on Glass.*—Apply a thin coating of wax to the glass with gentle heat. When cool draw the design on the wax with a hard-pointed instrument so it penetrates through to the glass. Apply an aqueous solution of hydrofluoric acid to the design with a soft brush. Apply several times to get deep outlines. Finally wash the acid off and remove the wax by heat.

5. *Imitation of Ground Glass.*—A paint for imitating ground glass is made by rubbing down some zinc oxide with linseed oil on a slab to a thick cream. Apply to the glass thinly and stipple with a stiff brush.

6. *To Make Window Glass Sun Proof.*—Pulverize gum tragacanth and let it dissolve for 24 hours in the white of eggs, well beaten. Lay a coat of this on the window panes with a soft brush, let it dry, and you will have a coating the rays of the sun cannot penetrate.

Gold-plating Without a Battery.—Clean the article to be plated with a brush and ammonia water until it is bright and untarnished, then take a small piece of gold and dissolve it in four times its volume of metallic mercury, which forms an amalgam. With a dry cloth rub a little of this amalgam on the article to be plated, then place it on a stone in a furnace and heat to the beginning of redness. After it cools clean with a brush and a little cream of tartar.

Silver-plating Powder.—Chloride of silver, 3 oz.; salts of tartar, 6 oz.; prepared chalk, 2 oz.; common salt, 3 oz. Mix. Dip a moist cloth in this powder and rub the article to be plated.

Contributed by MYLES S. CLOSZ.

ACID INK ERADICATOR.

An ink eradicator quite as good as those manufactured is given below:

Add 110 grams of *chloride of lime* to *1 liter of water;* let the solution stand for 24 hours, then strain through fine cloth and add *10 parts acetic acid* to each 25 parts of solution.

To erase ink, apply with reverse end of a penholder, and dry with a blotter.

REMOVING HARD RUBBER SCRATCHES.

To remove scratches from hard rubber pass a heated soldering copper over a thickness of paper laid on the surface of the rubber.

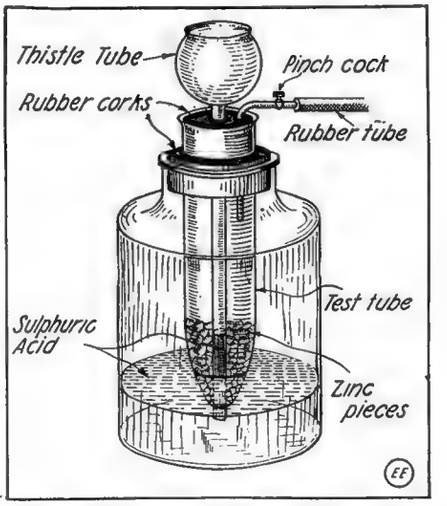
Contributed by FRANK SKINNER.

HOME-MADE GAS GENERATOR.

A neat and efficient hydrogen gas generator from which a supply of gas is available at any moment, can be very easily made of a wide mouth bottle, a test tube, two (preferably rubber) corks, a glass thistle tube and a wire pinch cock.

The bottom of a test tube is heated and drawn to a point, the point is then nicked off with a file leaving a hole large enough to loosely admit the lower end of a long thistle tube.

The thistle tube and a delivery tube are placed in a two-hole stopper and inserted in the test tube. The end of the thistle



A Handy Gas Generator Made from Odd Parts Found About the Work-shop.

tube should protrude from the test tube about one quarter of an inch.

The test tube is then mounted in a large single hole stopper and placed into the neck of a wide mouth bottle. After slipping a piece of rubber tubing over the delivery tube, the apparatus is ready for use.

Place lumps of zinc to be acted upon by the acid into the test tube as shown. Now pour the diluted sulphuric acid (4 parts water, 1 part acid) into the thistle tube until it is full. The acid will soon reach the zinc and react with it, giving a steady supply of gas.

By closing the rubber tubing with a pinch cock the pressure of the gas in the interior will force the acid up the thistle tube, causing the chemical action to stop.

Contributed by JOSEPH R. MAYER.

CEMENT FORMULA.

Powdered Casein No. 98—4 ozs.
Powdered Slaked Lime—5 ozs.
Powdered Barytes—20 ozs.

Mix thoroughly.

In use pour a little of the powder into any convenient vessel, add sufficient water to form a stiff paste, and work or stir with a small stick until thoroughly mixed.

Let this mixture stand for 20 minutes before using. *This is important.* The article to be mended should be free from all dirt and grease before applying the cement, and should be perfectly dry.

For Mending Holes in Pots, Pans, etc.:—Fill the hole with the paste, applying to both inside and outside surfaces, allow it to dry for four hours, then fill the vessel with water, place on the fire and let boil, pour out the water, wipe dry and let stand in the air for two to six hours longer. If desired, after the cement is thoroughly hardened, the place may be smoothed up with sand paper. For extremely large holes place the vessel to be mended on a piece of paper, and fill hole with the paste from the inside. Let the paper remain until the cement is thoroughly hardened, then burn off. *Do not tear off.*

For Mending Marble, Glass and Bric-a-brac:—Apply the paste to both broken surfaces in a thin layer, press closely together and allow to harden in the air for six to twelve hours.

Do not omit letting the mixture stand for twenty minutes after mixing with water. This is essential for the casein to become thoroughly dissolved and amalgamated with the remaining ingredients.

Ink-Erasing Blotter:—Take an ordinary sheet of thick blotting paper and steep it several times in a solution of oxalic potassium, and dry. While the ink spot is still moist apply the blotter, and the ink will be entirely removed. If the ink is dry moisten and apply the blotter.

Contributed by S. ENGLISH.

STENCILS FOR CHEMISTRY STUDENTS.

All students of chemistry, whether they attend a residential school or not, have undoubtedly often wished for some form of transparent stencil with which they could artistically, yet rapidly draw diagrams; and especially sectional diagrams of the various flasks, test tubes and retorts used in such work.

Such stencils have recently been brought out by an English scientific house, and they are described in a current number of *Nature.* This excellent set of stencils, which have been approved and permitted to be used by students taking chemistry in English schools and colleges, have been officially approved by the faculty of the University of London and also by the Indian Education authorities.

Undoubtedly, instructors in chemistry in high-schools and colleges will be pleased to have their students obtain such stencils, as the examination papers will then lend themselves to a much quicker perusal by the teachers. Moreover, they help the student to keep first-class notes in his data book and not a mixture of harum-scarum sketches, which are often so poorly executed that they are absolutely unintelligible when referred to at some future date.

HOW TO MAKE A VOLCANO.

Take a bowl or crock about 6 inches in diameter and fill it up with earth, so that it resembles a miniature mountain. Make a hole about ¾ of an inch in diameter and 6 inches deep for the crater.

Fill up this crater with a mixture of potassium chloride 3 parts, sulphur 1 part, charcoal 1 part, wax 2 parts and sugar 2 parts. Now light the mixture in the crater. The result will be a dense smoke, fire coming from the crater with lava pouring down its sides.

Contributed by THOS. McCAUSLAND.

He Becomes an Erector Engineer

Next an Expert

ERECTOR

Hello Boys! Look at Jack in the picture here—and then put yourself in his place! He is now a member of The Gilbert Institute of Erector Engineering—and you can be a member, too, when you own an Erector set.

Then when you're a member of the Institute you have something to look forward to, like Jack—you can go in to win the three Erector Engineering Diplomas and other worth-while rewards. Can't you see yourself winning the First Diploma or Degree of Honor—then the Second—then the Third and highest Honor of **Erector Master Engineer?** Maybe you can look as far as Jack does and see yourself, when you're a little older, as one of the famous grown-up Master Engineers of our Country, who build great bridges, buildings and canals.

Think it over for a minute—think of the fame, high Honors and Rewards you may win—and think of the fun, **lots of it,** that you'll be having all the time you're trying!

It's Play That Boys Like

I started the Gilbert Institute of Erector Toy Engineering to add to your fun with Erector. I for all kinds of fun when I was a b thing that boys like, and became Vaulter, won many medals at all learned how to do a lot of magic tric boy myself and know what real boy

I know you fellows don't care mu that do not require brains or skill. that kind of fun. That's why I inv to make Erector even **more** fun and Gilbert Institute of Erector Engine

As soon as you become a member o to the Fraternity of Erector Engine to go after the three Degrees of Ho go with them.

ERECT

"The Toy Like Structu

Get These Big Advantages in Erector

1. The only actual structural steel toy. 2. The interlocking-edged girders (an exclusive patented feature) enable you to build square columns. 3. Each piece is stamped accurately out of steel—correct in design and proportion. 4. Most parts for building strongest and largest models. 5. Builds suspension bridge 21 feet long, capable of supporting a large and heavy boy. 6. The sturdy electric motor comes with most sets and will lift 200 pounds when properly geared. This is a scientifically constructed motor built by an electrical expert. More than a toy. Operates with reversing switch base, control switch, multi-geared motor box, etc. 7. Big reenforced steel wheels; grooved and hubbed for every engineering purpose. 8. Every essential engineering part. 9. The three big manuals show over 500 actual mechanical models which have been built with the No. 4 set alone. In addition to those illustrated, thousands of other models can be built depending only on your originality and skill.

$5,000 Prize Contest

Get into this Big Prize Contest boys! Go in to win the splendid First Prize—a dandy, new, up-to-the-minute Saxon Automobile. Or, if you are under 12 years old, go after the finest little Shetland Pony you ever saw.

There are a lot of other fine prizes, too—motorcycles, bicycles, camping outfits and 495 others. Make up your mind to win one—and go to it. Mail the coupon in opposite corner for full details.

HERE'S A DANDY

Look at this picture of Erector No. 4 set. It is the **set of all,** because it includes the Erector electric m hundreds of parts. There are big girders, large an shafting, corner plates, angle irons, pinions, pulley nuts and bolts—in fact, practically all essential parts for building all kinds of structures.

The sturdy electric motor is a wonder, and yo great fun with it. It is better than many motors c or four times as much. It has four terminals; opera at a touch of the switch; works quickly and takes evenly. It will easily lift 200 pounds when properl

You can build at least a thousand good models wi motor enables you to make many that operate just li

You don't have to build only models found in the tion which come with each set. It is easy to invent of your own. Hundreds of boys have done this wi won valuable prizes.

See what you can make and win a valuable pri your chum in with you and build all kinds of buildi machinery that you can operate.

The more you build with Erector the more fun to build miniature reproductions of famous engineer Canal Locks, Brooklyn Bridge and the Eiffel Tower, A

Erector sets range in price from $1 up to $25. you lots of fun, while, of course, the larger ones e and better models.

Canadian boys, of course, are just as eligible for boys of the U. S. A. In fact, boys all over the worl Engineering Honors, and compete in the Big Prize

Ask the man in your toy store to show you the will be glad to do it, and to tell you all about it. Y ing—and the size of girders, until you see a set of

Erector No. 4, Price $5.00. (Price in Canada

Thousands of boys in every section of the United It is the dandiest Christmas present you could ask ing the big Erector bridges, elevators, that you can r and lift steel beams. In fact there's nothing mec

THE A. C. GILBER

Engineer *Then a Master Engineer* *and Finally in Real Life*

. Toy Engineering

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Win These Honors and Other Rewards

First Degree—It is quite easy to win this Degree. All you have to do is to send us a photograph of an Erector model you have built, with or without a motor—or of a motor built with the Erector Electrical Set—or of a building made with Brik-tor. Then we will send you a fine Diploma, giving you the title of "Erector Engineer," as a testimonial to your skill.

Second Degree—This Degree is a little harder to win, but easy for the boy who has a little steam back of him. This time you earn not only a Diploma which awards you the Degree of "Erector **Expert** Engineer," but also a handsome button which you can show to your friends as proof of your brains and skill.

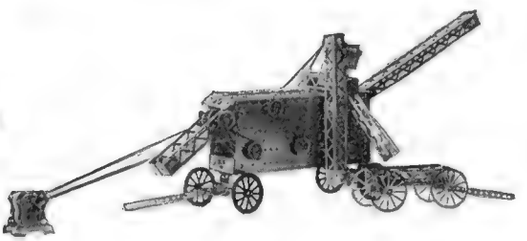
Third Degree—Here is the hardest of all Honors to win, but one well worth trying for! Your reward is a Diploma, with the title "Erector **Master** Engineer," a handsome rolled gold Fraternity Pin—a good salaried position with us during the holiday season—and the finest recommendation which can be written for you to any business house to whom you may wish to apply for a position.

START NOW!

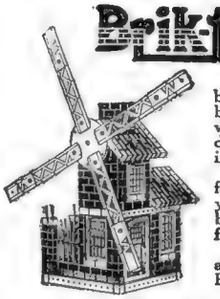
Think of the fun you'll have trying for these Honors and other Rewards! And remember, you may win one of the prizes in our $5,000 Prize Contest, too. Join the Erector Engineers, now. Start just as soon as you can! There's something to this kind of fun—you may be the fortunate boy who will win the biggest prizes and Honors this year.

TOR

ural Steel"



Brik-tor For "Bricking-in" Steel Structures



Finish up the brick work of your Erector buildings with Brik-tor. With these bright red bricks, the slate ones for roof effects, and the white pieces for trimming—not to mention the doors and windows—you can make the buildings even more like the real thing.

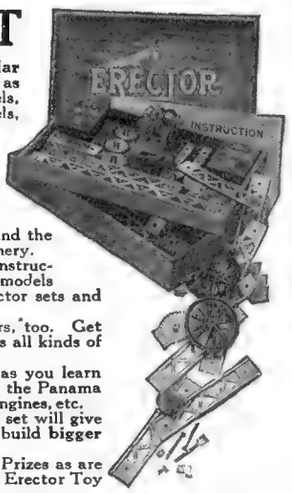
You can "brick-in" the walls, chimneys and foundations of your buildings—the towers of your bridges, and the piers. There's a fine big book of instructions chock-full of pictures free with each set.

See one of these sets at your toy store—and you'll see what fine work you can do with Brik-tor. Price $5.00. In Canada $7.50.

ERECTOR ELECTRICAL SET

Be an Electrical Engineer! This is the Electrical Age! In the Erector Electrical Set of Experimental Apparatus together with the illustrated elementary course on Electrical Engineering we offer the most fascinating plaything for teaching, demonstrating and applying the secrets and principles of electricity that has been gotten out. You learn and play. It is the most fun you ever enjoyed. It contains all parts for building motors and other apparatus, also for conducting 100 experiments. Price complete, $5.00; in Canada $7.50.

Y SET



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Diploma and Prizes as are
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No. 4 set—or any other sets you may wish. He
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Erector.
$7.50.)
States are building great models with it every day.
or. You and your chums will never tire of build-
un by electric motor, or derricks that swing around
hanical but can be duplicated with Erector.

All Boys Know This Toy

Of course you know that Erector is the steel construction toy which enables you to build all kinds of machinery, bridges, buildings, battleships and hundreds of other things. Each set contains the steel parts such as are used in actual construction and it's easy to copy every sort of machine or bridge or building out of the real steel girders and other parts

Boys! Erector offers you a wonderful feast of fun. When you own a set, you have "the best known toy in the world." Not only that, but you become a member, free, of the Gilbert Institute of Erector Engineering and have the opportunity of winning fame, honors and other worth-while rewards. Then added to that you can enter the Big Prize Contest and perhaps win an automobile, a pony or one of the other 498 fine prizes.

Thousands of boys will be made happy by receiving Erector Sets for Christmas. It will please them better than any other toy because they know it will give them the kind of fun that is always new and chock-full of interest.

Be sure to get your set this Christmas.

A WORD TO PARENTS

ERECTOR will give your boy in generous measure, the best kind of fun. He will learn while he plays. His play will be along the constructive lines that build character and prepare him for the world of business. Erector Toy Engineering will awaken his ambitions—it gives him play with an object. You cannot choose a gift that will please him better for Christmas.

Send For *Free* Copy of "Erector Tips"

I want to send you absolutely free, the November issue of my boys' magazine, "Erector Tips." It's full of stories and photographs—all made especially for you. It tells what other Erector boys are doing, too—and gives full details about Erector Toy Engineering and the $5,000 Prize Contest. I want to present, also, with my compliments, my big book telling all about my toys and the things I do for boys. Send for your free copies of "Erector Tips" and the book now, as the number I can supply is limited—just mail the coupon below to me, after you have filled it in.

MAIL THIS COUPON

The
A. C. Gilbert
Company,
160 Fox Street,
New Haven, Conn.

Please send me, free, the November issue of your boys' magazine, "Erector Tips," and your big book, "How To Become an Erector Master Engineer."

NAME .....

ADDRESS .....

T COMPANY, 160 Fox St., New Haven, Conn.

WITH THE AMATEURS

Our Amateur Radio Station Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of stations unaccompanied by that of the owner. Dark photos preferred to light toned ones. We pay each month **$3.00** prize for the best photo. Make your description brief and use only one side of the sheet. Address the Editor, "With the Amateurs" Dept.

AMATEUR RADIO STATION CONTEST.

Monthly Prize, $3.00.

This month's prize-winner.

LEE MOCICKE, A CHICAGO "RADIO-BUG."

My wireless station includes the following:

The sending set—a 1 K.W open-core transformer, rotary spark gap with motor speed regulator, oil immersed condenser and oscillation transformer. A 1-inch coil is also used.

The sending aerial is 60 feet long by 50 feet high and has 4 wires. This aerial is also used for receiving, together with a single wire, 175 feet aerial of stranded wire.

A Navy type loose coupler, two variable condensers, loading coils, galena detector, variometer and an amplifier of my own design and construction complete the receiving set.

Amateurs in Chicago come in clear and 8 AEZ, is heard occasionally; NAR, NAA,

Prize Winning Radio Laboratory of Lee Mocicke, Comprising an Efficient 1 K.W. Transmitting Set, Together with Effective Receiving Apparatus, Built by Himself.

as well as Great Lake boats and Gulf stations can also be heard.

LEE MOCICKE.

Chicago, Ill.

AN AMATEUR WIRELESS ECHO FROM PITTSBURGH.

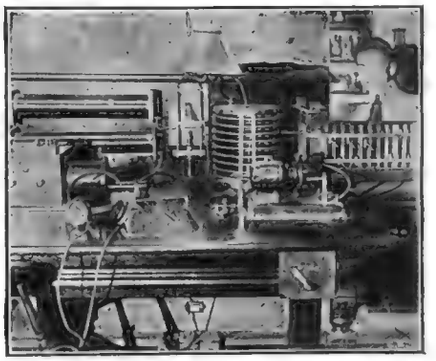
Herewith find picture of the 8 IB radio station of Pittsburgh, Pa.

The sending outfit consists of a ½ K.W. closed core transformer, glass plate condenser, helix, high speed rotary gap and a sending key fitted with large silver contacts. The transformer has three variations of power and a rheostat controls the speed of the rotary gap.

The aerial is situated on a hill overlooking the Ohio River and is 120 feet long, supported on two iron poles each 40 feet high. It is of the inverted "L" type with 4 wires spaced 4½ feet apart.

For receiving I use a long wave loose coupler having loading inductances in the primary and *secondary* circuits, galena detector, condenser and a pair of 2,000 ohm 'phones.

I have heard practically all the high-powered commercial radio stations, as well



C. E. Mielke and His Excellent Radio Station which Has Picked Up Signals from Far and Near.

as the smaller ones, along the coast and Great Lakes and have talked to a countless number of amateurs within quite a large radius.

C. E. MIELKE.

N.S. Pittsburgh, Pa.

ROBERT J. ENGLER TRANSMITS OVER 600 MILES.

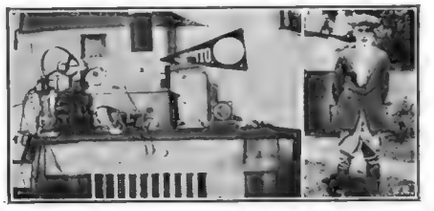
I hope the description of my station and the pictures accompanying it will be of interest to E. E. readers. I have one aerial forty feet high and forty-five feet long for transmitting and a long aerial, four hundred feet long by sixty high, two wire, for long wave receiving.

The entire transmitting set is placed in a closet, so as to reduce the noise and also to get it out of the way. I have rolled up quite a record with this outfit of over 600 miles.

It consists of ¾ K.W. rotary spark set, operated on 60 cycles A.C. It has a spark frequency of 345 per second. With it I put 2⅗ amperes into my aerial at 200 metres.

The receiving set is so designed that I am able to receive waves from 200 to 16,000 meters in length. I use a circuit similar to that of Mr. McKnight's, but with a number of changes of my own.

With this set I have copied NAA, NAR, NAO, NAJ, NAT, VAN, WGG and WSF. I have also picked up POZ, OUI and NBA, including 9NN, 9DB, 9SP and 9RA.



Complete Radio Equipment of Robert Engler, with which He Has Heard "POZ," Germany, and Other Distant Stations.

I would like to tell about the many interesting messages I have received, but of course this is against the law.

ROBERT JOSEF ENGLER.

Minneapolis, Minn.

RUSSO-JAPANESE WIRELESS.

Testing of the wireless telegraphic communication between Ochiishi, Hokkaido, and Petrovsk, Kamchatka, has been successfully carried out, and an agreement has recently been concluded between the Japanese and Russian authorities relating to the same. Preparations have been completed whereby the wireless service will come into actual operation at any time which may be agreed upon. The new wireless communication is, in the meantime, to be employed when the ordinary cable lines between Russia and Japan are interrupted.

The Russian wireless station affected by this arrangement is on the peninsula of Kamchatka, one of the boundaries of the Sea of Okhotsk. From the southern point of Kamchatka a string of islands—the Kurile islands—runs in a southwesterly direction to the most northern island of Japan—Yezo. Here is the first Japanese wireless station, at Hokkaido. Between 500 and 600 miles separate Yezo from Kamchatka.

GUY L. BEECH'S RADIO STATION.

My receiving set here illustrated consists of a pair of 3,000 ohm Murdock special 'phones, fixed condenser, loading coil, a

Guy L. Beech at His Radio Instruments. He Holds a Certificate of Membership in the "Radio League of America," Also Government Station and Operating Licenses.

3,000 meter loose coupler of my own make and a detector.

For sending I use a good telegraph key, the platinum contacts of which have been replaced by E. I. Co., silver contacts, ½ K.W. closed core sending transformer, helix, spark gap and condenser.

I can receive 1,500 miles and transmit from 50 to 100 miles. I hold an amateurs' second grade operator's license and second grade station license and am a member of the *Radio League of America.* My official call is 9 CL

GUY L. BEECH.

Clarinda, Iowa.

SUCCESSFUL COMMERCIAL RADIO TESTS WITH JAPAN.

The third and final series of tests for trans-oceanic radio service between Honolulu and Japan has just been completed. Telegraphic reports indicate that these tests are by far the most successful of any so far made. Communication has been maintained in both directions, night and day.

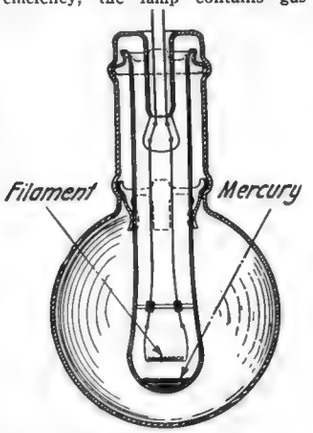
LATEST PATENTS

Incandescent Lamp

(No. 1,194,643. Issued to Hans Kreusler, Hans Gerdien and Marcello von Pirani.)

This patent relates to a special construction of carbon or metal filament incandescent lamps and particularly to the use of a concentrated filament. The patentees claim that a carbon filament is superior to a metal filament in many ways and that its temperature may be run extremely high by virtue of the compact arrangement of the filament spirals, etc.; and, moreover, that the watt consumption of the lamp is reduced.

To further realize an improved efficiency, the lamp contains gas



which is considerably above atmospheric pressure, allowing the carbon filament to be worked at high current density. Mercury vapor is desirable for these lamps and is carried in a small cup as indicated. The gas filling may include some nitrogen or argon.

Strong glass bulbs are specified, also a wire mesh glass, as a protection against bursting of the chamber due to the high gas pressure.

Electrical Sound Producer

(No. 1,197,910; issued to Edward E. Clement.)

A novel scheme utilizing an electrical device for vibrating a column

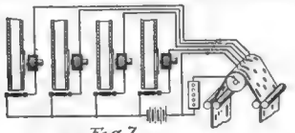
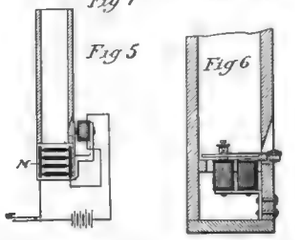


Fig 7



of air in a horn or organ pipe, etc. A column of air may be vibrated by a buzzer, Fig. 6, or by utilizing an electro-magnet in front of a reed, Fig. 5, the pulsatory character of whose magnetic pull is occasioned by the reaction of the vibrating column of air on the microphone, M; e.g., when the circuit is closed thru the electro-magnet, the reed is plucked, which reacts on the microphone (M) and thus causes repeated plucks by the inherent electrical control of the circuit brought into play until the column of air in the horn or pipe is in full vibration.

It is not commonly known that if an ordinary buzzer is started vibrating in a pipe, Fig. 6, after the column of air in the pipe is started vibrating, it will take control of the buzzer and cause it to vibrate in unison with it.

Battery Lamp

(No. 1,200,366; issued to John F. Kerlin.)

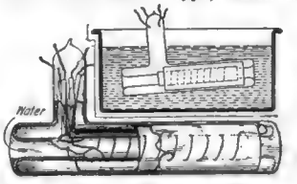
This invention is one of the most ingenious yet brought out. It involves the design of an extremely low-priced flashlight wherein the battery bulb and socket, as well as the switch are made up in the ordinary dry cell container.

The reflector and socket elements are molded in the pitch filler at the top of the cell.

Vacuum Tube Design

(1,196,474; issued to Alexander McLean Nicolson.)

An ingenious vacuum tube device of the Audion type, which is



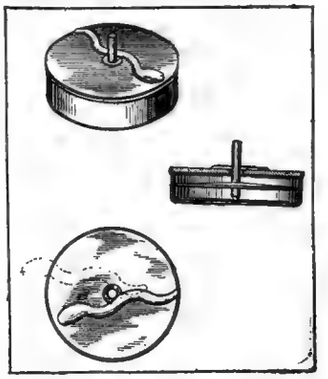
provided with an internal passageway, as shown. Hence the device may be placed in a vessel containing water or other liquid, and a stream of water may be caused to flow thru as well as around the bulb. The tube contains the usual filament, grid and wing.

The leads to the various electrodes are brought out by having wires fused into the glass; the opposite end lead to the filament passes thru a glass tube.

Magnetic Top

(No. 1,198,578; issued to George H. Reimer.)

This invention relates to toys of



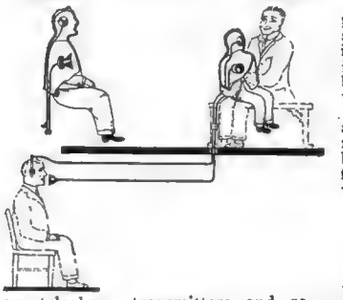
the kind in which a magnet is mounted for moving or agitating about at the upper surface of the toy a piece of metal of any desired form, as for instance, that resembling a snake.

The permanent steel magnet consists of a vertical post with a disk rigidly mounted on it which rotates within the top itself. When this post is twisted by the thumb and finger the disk will cause it to rotate rapidly. The curved piece of iron oscillates about the upper surface of the top in grotesque fashion. Several snakes may be agitated at the same time. The snake is best made up of convex cross section and its form composed of compound curves.

Theatrical Telephone Set

(No. 1,197,543; issued to Charles P. Price.)

Embraces a scheme for rigging

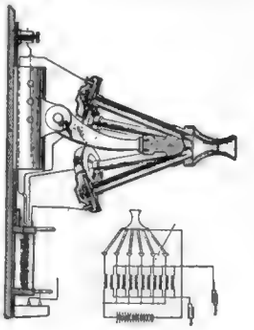


up telephone transmitters and receivers to a small dummy figure such as used by a ventriloquist on the stage. The operator speaks to the dummy and his words are carried by the microphone circuit in the dummy's head down to an assistant below the stage. The assistant can then (apparently) cause the dummy to speak by talking into the microphone in front of him, the speech being reproduced by the loud speaking telephone receiver in the breast of the dummy.

Wireless Telephone Transmitter

(No. 1,200,210; issued to Frederick Hoyer Millener.)

A multiple wireless microphone unit comprising a plurality of mi-



crophones connected with the primaries of small telephone transformers and a suitable battery, as shown.

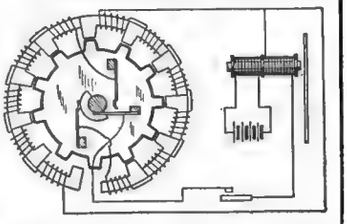
The secondaries of these transformers are connected on parallel and a compound effect produced by the voice actuating all the microphones simultaneously. This effect is carried electrically thru the condensers to the radiophone circuit which is to be controlled. Heavy currents can thus be modulated by the ordinary voice.

By designing the microphone chambers, as well as the tubular channels between them and the mouthpiece very exactly, it is possible to secure, in an as yet not very well understood manner, acoustic resonance and amplification of the voice. This is further augmented by the use of a megaphone chamber just beyond the mouthpiece.

Tone Producing Means

(1,199,934; issued to Melvin L. Severy and George B. Sinclair.)

An electromagnetic scheme for



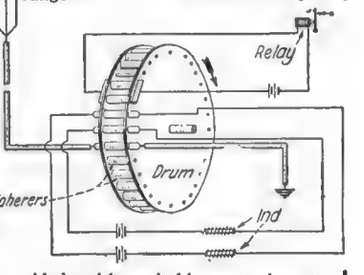
producing various tones of any desired frequency. A rotor, or plurality of rotors, having projecting teeth is used and these are surrounded by toothed stators having coils wound on them.

The various alternating currents are passed thru a series of electromagnets which are polarized by battery current. Its magnetic field first attracts, then repels, and thus vibrates a musical string.

Improved Radio Coherer Scheme

(No. 1,201,034; issued to Edwin R. Gill.)

The patentee of this invention uses a considerable number of coherers of the usual pattern, arranged in a rotatable drum pro-



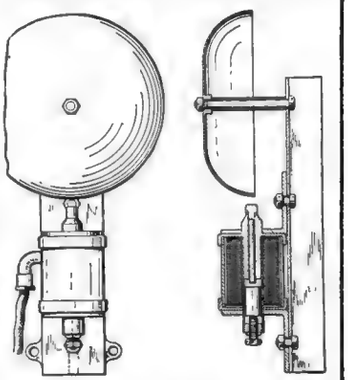
vided with switching attachments.

First, the coherer is connected to aerial and ground and after it is imprest with an etheric wave current, it is the recipient of an inductive discharge current from the battery and inductance coil shown.

Electromagnetic Bell

(No. 1,199,699; issued to George Henderson.)

An improvement in a waterproof single stroke electric bell. The lead wires are past thru a downwardly deposed conduit, as shown, and the reciprocating parts, including a striker, are accurately



designed with an overhanging skirt on the head of the striker, so that no water can possibly enter the armature chamber or that of the coil.

PHONEY PATENT OFFIZZ

Monthly Prize of $3.00 for the Best One Submitted

No. $\sqrt{\frac{\text{N. W.}}{\text{S. O. S.}}}$ P. M.

A. FRANK FURTER OF HOTDOG, DEL.

STAIRMOTOR

Patent Amputated

To Whome It Quite Concerns:

Be it knowed to All Ye and others, that, I, A. Frank Furter of the City of Hotdog, in the County of Canine, in the State of DELirium have succeeded successfully and with complete success of inventing devising and improving and otherwise creating a new means of making use of a tremendous latent energy, which has gone to waste since the days of Noah.

Now that it has been calculated by our scientists that all coal will give out on our planet in less than 100 years, it is of the tallest as well as highest importance that a new supply of energy must be found to provide humanity with heat, light and power.

Ever since the earliest dawn of humanity man has walked up and down (and fallen down) stairs. Every time a man walks up (or down) a stairway, say 50 feet high, this man—with an average weight of 150 lbs.—expends a useful energy value of of energy must be doubled. This gives the overwhelming, titanic total of 34,816,800 horse power gone to waste each day. In one year this wasted energy amounts to the stupendous figure of 12,708,132,000 Horse Power!!!

This is far more power than is required to run all the electric lights, trains, factories, power plants, vacuum cleaners, door bells and pocket flashlights of the entire world and this energy hitherto gone to waste has been harnessed by me, now and forever after.

As all great inventions, the *Stairmotor* as my own revolutionizing discovery is termed, is so simple that it will make great inventors turn a vivid Paris green with envy.

The accompanying Patent Drawing reveals the invention better than words could do. For those Boneheads, however, who are devoid of understanding, the following short description will be of use.

(10) Supply pipe through which the air is fed to the turbine. (11) Outlet for air which may be used over and over again.

It should be understood that all the bellows have check valves in order that the air in pipe 10 remains under constant pressure at all times.

Other technical refinements apparent to any engineer need not be shown here, as they are obvious for the continuous operation of the device.

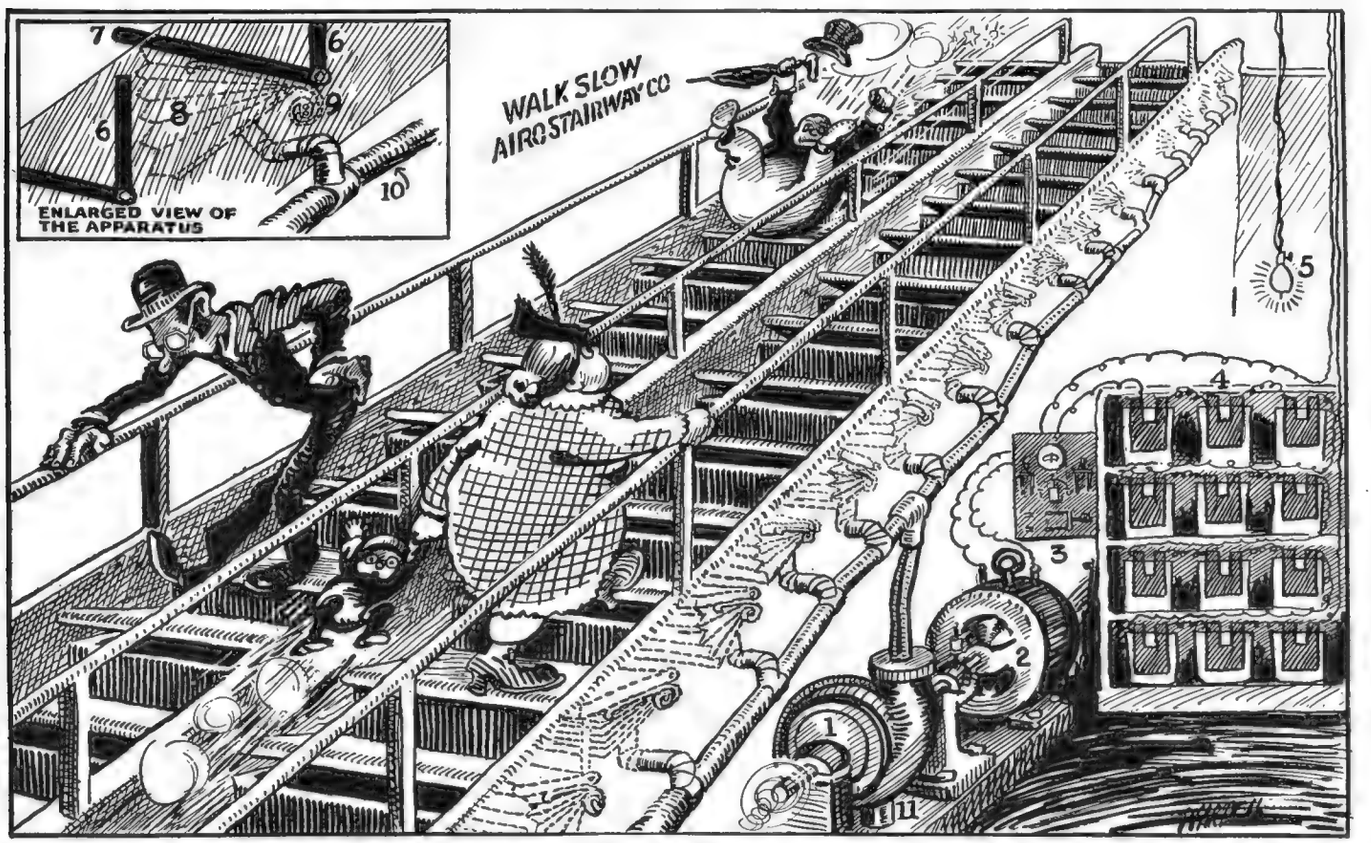
What I claim is:

(1°) A stairmotor, making stair walking easy, on account of the pneumatic tread.

(2°) A stairmotor working equally well on hot air as well as cold air merchants.

(3°) A stair motor, which by compressing the available air supply of the earth, keeps it from becoming hard of old age.

In Halfwittedness whereof, I have hereupon exprest and supprest my glorious *nom-de-plume,* this 11th morn at 7 A.M. in the afternoon while the telescope regis-



The Efficiency Engineer of To-day Is Truly a Wonderful Being. Here We Have an Electro-Pneumatic Contraption by which the Energy Wasted in Ascending and Descending Stairways May Be Applied to a Series of Bellows which Pump Air Into a Hot-Air Motor; This in Turn Drives an Electric Dynamo Charging a Storage Battery. Why Pay $3.49824½ per Month for Electric Lights?

tered 65% Fahrenhide in the shades of Hades, taken on the 99th Degree latitude by 78¼% lassitude west of Green which.

A. FRANK FURTER,
By His Attorney,
John Golubski,
Chicago, Ill.

Witnesses:

Mack Arony.
Phil Harmonic.
Pete Roleum.

7,500 foot lbs. Exprest in Horse Powers this comes to .2275 Horse Power for one man scaling the stairway. Just think of this colossal waste. Now careful statistics show that on this globe at least 978 million people walk up a flight of stairs of an average height of 32½ feet each and every day (Sundays and Holidays included). This gives a grand total of 17,408,400 Horse Power a day. But as the 978 million people must walk down again also during some time of the day, the amount

(1st) Air turbine driven by comprest air which is produced by stepping on the steps. (2) Dynamo propelled by the turbine which in turn charges the storage batteries thus collecting all energy. (3) Switchboard. (4) Storage Batteries which collect the "juice." (5) Tungsten lamps of tetrahedral design. (6) Lower side board of stairway. (7) Hinged stair-steps. (8) Bellows which charge the turbine. (9) Spring to bring steps back to original position after it has been comprest by Man.

QUESTION BOX

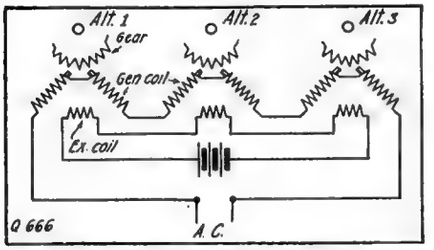
This department is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be published. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., **must** be on separate sheets. Questions addressed to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of **25 cents** is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

HIGH FREQUENCY ALTERNATORS.

(666.) A. Baldock of Middlechurch, Manitoba, Canada, wishes to know:

Q. 1. Would it be feasible to use several high frequency generators, as described on page 415 of the October, 1916, issue for generating power for other purposes than testing crystals?



Connection of Three "Gear Type" High Frequency Alternators in Series with Battery Excited Fields.

A. 1. Several high frequency alternating generators may be used in series; the electro-motive force of the total generating unit can be increased so that it will be possible to use it in radio transmission work. However, the efficiency lost in operating such machines in series or even in parallel is so great and the energy developed when such an arrangement is completed is so small, that it would not be practical for serious work. Furthermore it is necessary to synchronize each individual machine in the complete unit in order that the generated E.M.F. and current shall be sinusoidal.

Q. 2. What is the voltage and amperage of each machine?

A. 2. The current generated by such a machine would be in the neighborhood of about .1 of an ampere, and the voltage may be as high as two to three volts, so it is quite obvious that a large number of them will be required in order to use the current generated by the complete arrangement for radio telephony. As the amount of current necessary for satisfactory transmission work is in the neighborhood of 50 watts, this means that about 50 or 100 volts are required with a current of ½ to 1 ampere.

Q. 3. Give a diagram of connections for using several machines.

A. 3. The diagram herewith gives the connections for three units; however, more can be connected as desired.

NOISES IN THE HOUSE TELEPHONE.

(667.) Rudolph Wenski of Cleveland, Ohio, inquires:

Q. 1. When I use my transmitting apparatus it makes such a noise in our house telephone that it cannot be used. What can be done to remedy it?

A. 1. The only reason we can see for the noises in your telephone is that one of the transmitting wires are either parallel to the telephone line or else they are touching it. It may also be due to induced currents from the oscillatory circuit of the transmitter produced in the neighboring telephone line. The only means which you can employ for eliminating these unnecessary noises is to change the present position of your transmitting apparatus, and see that the connecting terminals of the various parts of the transmitter shall be so set that they are at right angles to the telephone line, thus reducing the induction between the two conductors. We would advise you also to connect one of the nearest telephone conductors in series with a condenser to the ground and in this way carry away the induced electrical disturbance.

Q. 2. In one of our fixtures a spark can be heard whenever I send. I have a kick-back preventer connected across the line, consisting of 2 one-M.F. condensers and the center connection grounded, but this does not help in overcoming the trouble.

A. 2. The reason you are obtaining a spark from one of your fixtures is that one of the transmitting terminals is grounded thus causing this effect. We would also advise you to reverse the aerial and ground terminals of the oscillatory circuit. You should have no trouble then in eliminating the spark appearing in your fixture. Too small a ground wire has been known to cause this trouble.

Q. 3. What is the approximate distance the stationary electrodes should be set away from the rotating contacts of a rotary gap with a ½ K.W. transformer, having a secondary voltage of 13,200.

A. 3. The sparking distance between the rotating member and that of the stationary should be about ⅛". However, this is only a guess as the factor of the distance between the two electrodes depends entirely upon the resonance condition of the oscillatory circuit consisting of capacity and inductance. Therefore, the condenser capacity is a prime factor determining the sparking distance. Transformer having voltage you mention is right. It is advisable, however, that you should use a hot wire ammeter in series with ground circuit and experiment a while with the distance between the electrodes until maximum reading of the ammeter is obtained.

TO OUR FRIENDS.

Do you realize that not one day passes when we do not receive from 150 to 250 or more letters addrest to the "Question Box"? If we were to publish all the questions and their answers we would require a monthly magazine five or six times the size of The Electrical Experimenter with no other matter but questions and answers! Of late the influx of letters has become so heavy that several of our associates have been forced to discontinue important editorial work, in order to answer the mail. This we are certain you do not wish. You do not want your magazine to lower its present high standard. You want the best, the very best, and you know we never have failed you yet.

Moreover the multitude of letters are wholly unnecessary. Most of the questions we are asked every day have been answered before in the Question Box. Therefore ere you sit down to write to us, look over your back numbers and nine times out of ten you will find the answer.

We strive hard to publish only such matter as has not appeared before in our columns, and for that reason only a small fraction of queries of those received by us are actually published.

Kindly note, therefore, that in the future we cannot, in your own interest, answer questions by mail, free of charge.

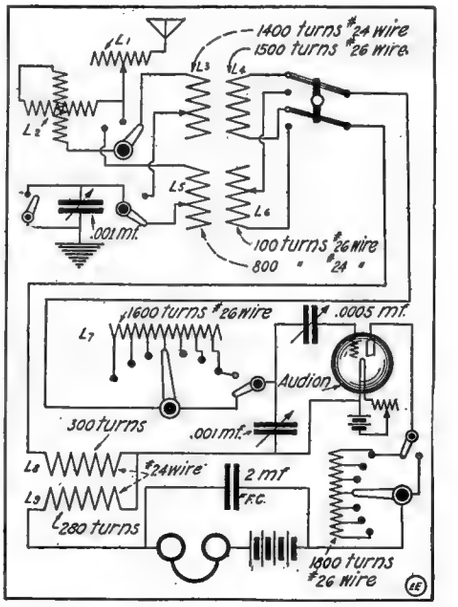
For questions requiring immediate answer our fee is 25c. for the first ordinary question and 25c. for each additional question. We will gladly advise fee for special questions entailing considerable calculations or research. Stamped and addrest envelope should be enclosed with the queries and, moreover, any sketches accompanying them should be made on separate sheets. And please be brief.

THE EDITORS.

DETAILS OF AUDION CIRCUIT.

(667-A.) Kalman Bernstein of Brooklyn, N.Y., wishes to know.

Q. 1. Could you give me a few suggestions for the improvement of the Higgs Audion circuit arrangements published in the June, 1916, issue?



Details of Composite Audion Receiving Circuit Adapted to Long and Short Waves.

A. 1. We cannot give you additional improvement over the circuit which has already been published.

(*Continued on page 594*)

A GIANT ELECTRIC TORPEDO THAT EATS THRU THE EARTH.

(*Continued from page 551*)

When it is planned to fire a subterrane torpedo at a fortress, or a citadel, the machine is lowered into a trench at the desired depth and carefully aimed towards the doomed place. It is then started on its way. Several days will elapse before it reaches its goal, maybe several weeks. All the time, however, the engineers are listening at the telephones that communicate over the cable with the microphones in its machinery and when at last they know it is below the fort they have only to touch the button that closes the electric circuit and makes a spark in the explosion chamber, when 400 cubic feet of dynamite or lyddite will hurl the enemy's fortifications into the air.

GUIDING TRAINS BY TELEPHONE.

(*Continued from page 556*)

secure an additional circuit by means of the phantom.

In October, 1907, the first successful installation of telephone and selector equipment for train dispatching was completed on the lines of the New York Central. This was closely followed by a number of installations on the Chicago, Burlington and Quincy, where it was proven, to the satisfaction of officials of other roads watching these first service tests, that the telephone and selector combination could be used equally well for single track as for double and multi-track operation.

These pioneers in telephone dispatching blazed the trail for the network of railroads traversing the United States and Canada. Out of a total of 285,000 miles of railroad in the two countries over 95,000 are now equipt for this method of handling train movements. Not only is the telephone and selector equipment used on the train wires, but similar apparatus is used on message wires for the transmission of messages other than those relating to train orders.

With the telephone, the dispatcher issues orders verbally, using the same terms and forms as he would with the telegraph, his speed being limited only by the rate at which the operator can copy the messages. The average railroad telegraph operator sends at the rate of 25 words a minute, while a speed of 100 words or more is possible with the telephone. It is only natural, therefore, that more business can be handled by the operators with less physical effort. Complete reports of the passing, arrival or departure of trains can be given in the fractional part of a minute and information regarding accidents and other occurrences outside of the daily routine sent to headquarters verbally in such complete form that the chances of misunderstanding and the necessity for additional messages are eliminated.

When the dispatcher wishes to call, he turns a key corresponding to the station with which he wishes to communicate. The loud ringing bell at the station called insures an immediate response, whereas the comparatively feeble click of the telegraph relay or sounder frequently causes a delay in answering. Furthermore, other stations may be called in on the line while a message is being transmitted. This is a feature used continually on heavy traffic divisions where there is a high rate of calling.

Accuracy in transmitting orders is assured by the practise of having the dispatcher write down the words as they are spoken and checking this record word for word, as the order is repeated back by the operator who has previously written it down simultaneously with the dispatcher. With the telegraph, the dispatcher writes down the order only when it is repeated by the operator and may not catch the errors in the repeat due to the natural impulse to write down the message as originally sent out by him.—*Photos courtesy Western Electric Co.*

WHY A MERE SPECK OF RADIUM COSTS $5,000.

(*Continued from page 555*)

crystallization. Then the radium chlorid and barium chlorid are treated with ammonium carbonate and the carbonates secured are dissolved in hydrobromic acid and are evaporated, giving bromid crystals. These crystals are then sealed up in glass tubes, and finally by what is termed "higher fractionation" the radium is separated in the form of *radium bromid.*

This is the present final state. Science up to now has not succeeded in producing pure radium metal.

It has been calculated that the radium in the ore is exactly or nearly 1-200,000,000 of the bulk, so it is easy to see that having to pass tons of material thru so many delicate processes, in order to secure what anyone would call a speck of dust, is a fair reason for the great cost of the radium when secured.

It is now claimed, tho it has not been proved to the satisfatcion of some critics, that radium can be produced in the United States for something less than $37,000 per gram, which is less than half of what it cost in the open market two years ago.

It should not be forgotten in trying to explain the cost of radium that it costs labor to get out the ore, and that it is now valued at about $120 per ton.

There is another reason, aside from that of production, which will go far toward explaining the value of radium. Just because there is so great a demand for it all the world over the market value is great, as is the case with any commodity of which the supply is very limited and for which the need is great.

Radium is being used for treating many diseases, from cancer all down the line to minor skin affections and inoperable diseases. Study of radium itself has shown that there are three main streams of rays emanating from a bit of radium. They have been called the Alpha, Beta and Gamma rays.

If a magnet be held near a bit of radium it will attract the Beta rays most strongly, the Alpha rays next, but the Gamma rays not at all. It is of the utmost importance to control these various rays, for while one kind are adapted to one affection another may be required for a second, while the first should be shut off. It has been found by experiment that a thin sheet of metal, or even a sheet of paper, will shut off the Alpha rays; a much thicker piece of metal is needed to shut off the Beta rays, and the Gamma rays will pass thru anything but lead, and that must be of considerable thickness to shut them off.

A safe for holding radium has therefore been constructed of very heavy walls of lead inside the steel chamber, so that the radium does not escape, or, rather, make itself felt in the room outside the safe. There is no thought of stopping the emanations, for that has heretofore proved impossible, and besides, a grain of radium will outlast many generations; so why economize in a practically inexhaustible source of energy?

The extraction of radium, properly considered, is therefore only one of the concentration of all of the stored up energy in the ore into the smallest possible bit, and this may explain why it is so costly.

One of the latest preparations for this purpose of rendering certain articles luminous in the dark, contains a base of zinc sulfid, together with a small quantity of radium bromid, the alpha-particles of which, continuously bombarding the crystals of the sulfid, render it luminous in the dark with a pale greenish glow of about the intensity of a rubbed phosphorous match. By increasing the quantity of radium compound included in the paint the more brilliant can this phosphorescent glow be made. On aeroplane compasses used by the European armies, the luminous compound employed is of such intrinsic brilliancy that its glow can be seen even in contrast with twilight. Such a high mixture of radium compound, however, rapidly disintegrates the zinc sulfid so that the life of the paint may be barely twelve months. In the intensity to be used on the new switches, which has been found most practical for average use on watch dials, etc., the figures are readily visible in a darkened room, and such paints have an assured luminous life of ten to fifteen years, if not longer. This latest product does not require to be placed in the light in order to make it glow. The action is continuous, being due to radium.

In order that ordinary flush switches already installed may be made luminous, the electrical manufacturer referred to has devised the ingenious expedient of luminous-head screws which can be used to replace the present screws, giving visible points of luminosity by which the switch can be located in a darkened room.

Possibly the most widely useful application of the genuine luminous *radium* paint is on watch dials. One of the largest manufacturers of watches in America has made preparations to bring out on the market even very cheap watches with *radiumized* dial figures and also the hands of these watches will glow on the darkest night.

It is reported that this particular watch manufacturer has spent $10,000 for the initial outlay in purchasing the necessary radium. The radium is mixed with a rather large quantity of zinc sulfid and when ready for application on the watches, as already outlined, the manufacturers' cost amounts to about $1.00 per square inch of the treated area, it is said.

One of the large electrical concerns is said to have successfully experimented with radium in a storage battery. A mere speck of the precious substance, properly placed in the electrolyte of the cell is stated to have produced wonderful results as regards output in ampere-hours; even to the point of boosting the output 25 to 30 per cent above the normal rating.

[*Those interested in radium will find a valuable discussion on its properties and energy components in the September, 1915, issue of this journal procurable at 15 cts. prepaid from the publishers.—Ed.*]

RADIO DRAFTSMAN WANTED.

Those who are well-versed in the radio art and are experienced in general electrical drafting, have an opportunity now to obtain a radio draftsman's position, which is being offered by the U.S. Government.

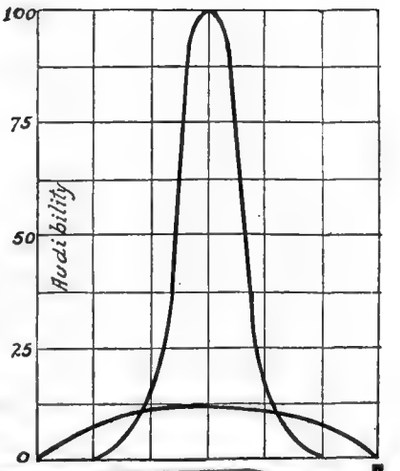
Examinations for this position will be held in all the principal cities where Civil Service examinations are given, on November twenty-first.

Those who desire to qualify for this position are advised to communicate with the Civil Service Board at Washington, D.C.

This is the first opportunity offered in many years to those who desire to enter the radio field.

Information as regards salary, qualifications, application blanks, etc., can be obtained by writing to the Chairman of the Board of Civil Service Examinations, Washington, D.C.

NOTE THAT PEAK



THE peak is what you get on a RA-6 regenerative receiving set—100 times amplification. The lower curve is the response you get on an ordinary set.

Just imagine the amplification—100 times—and the selectivity is just as great as the amplification. No damping in that peak signal, no interference even if that other station is on the same wave. When you get that peak, you are getting all there is to get out of any incoming signal.

How many times have you had a signal fade out, and tried everything under the sun to hold it just a second or two longer? Then study that peak. Note the difference—see all the strength of signal you have to spare over the strength of signals over an ordinary set.

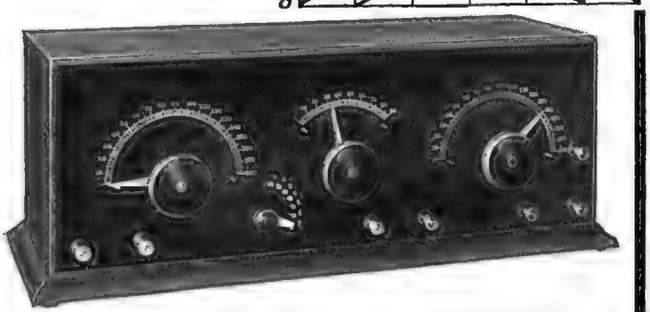
How about the stations you have never heard? Stop worrying because the fellow with the big aerial hears them and you don't. That peak will bring them in. The RA-6 will give you that peak.

This instrument is super-efficient, super-selective and super-sensitive. It was designed especially and solely for reception of **AMATEUR-WAVE LENGTHS** and its development has been carried on over a period of two years. It was the FIRST and is the ONLY worthy adaptation of the Regenerative circuits to short-wave reception. The antenna inductance is arranged in steps. **ASIDE FROM THIS THERE ARE NO SWITCHES.** Continuously variable inductances—carefully designed variometers are used in the closed circuits. **HIGH RESISTANCE CONTACTS, the capacity of switch points and leads, end-turn losses and the necessity for a variable tuning capacity are thus ENTIRELY DONE AWAY WITH.**

The antenna and closed circuits are INDUCTIVELY COUPLED and the COUPLING IS VARIABLE. The component parts of the instrument are not crowded into a small cabinet. The fact that ALL of these things are of extreme importance has been proven by the here-to-fore unheard-of **SELECTIVITY** and **AMPLIFICATION** obtained by owners of this instrument. Signals may be read from stations at extreme distances or through heavy static and interference with this instrument long after other receivers have failed, and WEAK SIGNALS MAY BE AMPLIFIED UP TO **ONE HUNDRED TIMES USING ONE AUDION ONLY.**

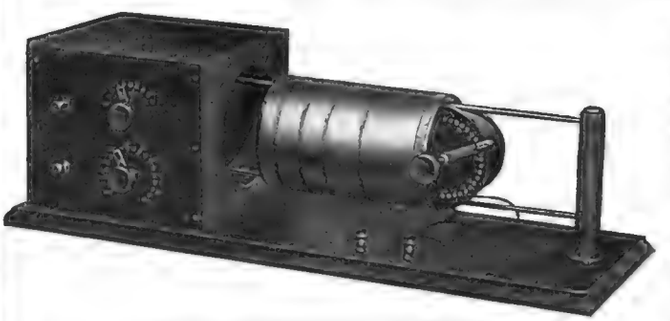
The RA-6, price $35, is as perfect mechanically as it is electrically. It is made right. Everything used in it is the result of long trial and experiment, to make a short-wave set that would give the greatest possible response to any incoming signal, on 180 to 580 meters.

Make that peak work for you ***now***. Write us ***now***.



R.A.—6—PARAGON AMPLIFYING SHORT-WAVE RECEIVER, $35.00
Range 180 to 580 Meters

PARAGON WIDE RANGE RECEIVING TRANSFORMERS



PARAGON RECEIVING TRANSFORMER
TYPE "L" $22.50 TYPE "S" $30.00 TYPE "X" $35.00

The methods employed in winding the coils eliminate leakage due to coloring matter in the insulation, put an end to the presence of moisture in the varnish, insulation and tube. The coils of the Paragon **"No-End-Loss"** transformers are divided into sections and fitted with **self-cleaning, positive-action** end-turn switches which connect and disconnect the winding as required, **entirely cutting off from the circuit** unused portions of the inductance and **completely eliminating end-turn effects on all wave lengths.** These switches are enclosed and are automatically controlled by the primary and secondary inductance switches respectively.

Panels, housings, switch heads, etc., are of polished black FORMICA, which is superior in every way to hard rubber and costs more. All metal parts are of gold lacquered brass. These instruments are adapted to extremely close tuning and due to the absence of end-losses are particularly recommended as the only receiving transformers on the market suited to the reception of amateur wavelengths or for use in conjunction with the AUDION-DETECTOR.

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For long wave work **$8.00**

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They are in a distinct class by themselves. There are no other instruments which can EQUAL THEM IN ANY WAY—regardless of price. WE CAN PROVE THIS ASSERTION TO THE SATISFACTION OF ANYONE.

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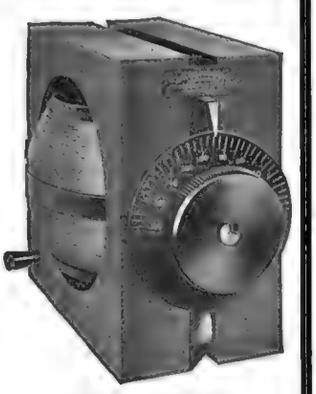
Our No. 7 Catalog shows several hundred different parts and also sets of materials for building your own apparatus. We do all the difficult work in our factory and give you the benefit of machinery and equipment.

Contains complete description and prices of all the latest Wireless and Electrical Goods.

OUR PRICES WILL SAVE YOU MONEY AND OUR PROMPT DELIVERIES WILL SAVE YOU TIME

THE BEST CATALOG OF ITS KIND IN AMERICA



VARIOMETER
Wound for any range. A necessity for the proper tuning of the Audion circuits on short wave lengths. **$9.00**

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"USE RADIOCITE IN YOUR DETECTOR AND FORGET IT"

WHAT IT IS

RADIOCITE is the most wonderful of all radio crystals. It is more sensitive than Galena and far more sensitive than ANY other crystal or mineral. RADIOCITE is a specially selected grade of a rare crystal chemically treated by our own secret process.

The mineral that looks like liquid gold. It has a highly and wonderfully polished surface giving it a burnished appearance. This crystal is now in use by several governments, and is conceded to be the most satisfactory of all, It is used with a medium stiff phosphor bronze spring, or with a stiff silver wire, about No. 30 B. & S. Gauge.

One of the important features of RADIOCITE is that it does not jar out easily. Each crystal is *tested for sensitivity* and guaranteed. RADIOCITE comes packed separately in a box, wrapped in tin-foil. Full directions accompany it. RADIOCITE can be mounted like any other crystal; it may be clamped between springs, but it is best to set it in *Hugonium* soft metal. Money refunded if our claims are not substantiated.

No. 3939. Generous piece of tested RADIOCITE. **Prepaid, $0.50.**

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236 Fulton St.,
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Cleveland, Ohio
Sept. 15th, 1916.

Gentlemen:-

Your piece of radiocite received in excellent condition and am glad to inform you that it is without doubt the best mineral ever put on the market. It has any silicon or galena beat forty different ways and back again. I have tried it out on an indoor set consisting of a piece of bare copper wire 20 feet long, a gas pipe ground, a forty cent detector and a pair of Brandes phones. This set was used merely for the purpose of testing Radiocite and the results obtained "knocked me off my feet". I have not yet tried it on my big set but if it works as good as it did on the small set - - why, I'll have "some" set.

Yours truly
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On your absolute guarantee that RADIOCITE is exactly as described by you, I enclose herewith 50 cents in .....for which you are to send me *prepaid* one box containing a generous piece of *tested Radiocite*. You accept my money with the understanding that you will refund it to me at once, should I find the RADIOCITE unsatisfactory. *You guarantee to ship within twenty-four hours or return my remittance.*

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Ye Announcement

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* * *
WHEN EVERYTHING was peaceful.
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CASES OF Electrical Goods.
* * *
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* * *
THEY REACHED Holland safely.
* * *
ON THEIR journey to New York.
* * *
AND WAR broke out.
* * *
AND PUT a stop to their journey.
* * *
AND ALL the time.
* * *
WE HAVE kept on writing.
* * *
TO THE authorities higher up.
* * *
AND WANTED to know.
* * *
WHY THIS hold-up.
* * *
AND RESPECTFULLY requested
* * *
TO LET peaceful people.
* * *
ENJOY THINGS.
* * *
PAID WITH good.
* * *
AMERICAN DOLLARS.

AND THE authorities.
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TIRED MAYBE.
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FROM OUR yelling.
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GAVE IN.
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CHEAPER THAN ever.
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WE THANK you.

With apologies to K.C.B.

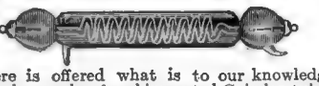
MEDICAL COILS

These coils, which come into use more and more every day, are adapted for the treatment of rheumatism, neuralgia, nervous complaints, etc. Persons who suffer from rheumatism in any particular part of the body sometimes find much relief from the use of electricity in this form. An ordinary dry cell not furnished by us will operate this coil.

This coil is really an excellent article. The strength of current is regulated by the regulator at the right side of coil. Pulling the graduated tube out increases the strength, pushing it in decreases it. Two kinds of currents can be taken off by means of the three binding posts. The identification plates of the posts are imitation ivory. A switch to turn the current off or on is provided. Base is of solid walnut. Handles highly nickeled and polished.

Large size Medical Coil, primary and secondary connections, 3½ x 4½ inches, with battery switch.
Shipping weight, 1 lb. - - - - - - **95c**
Only 480 on hand. If sold, money back.

GEISSLER TUBES



Here is offered what is to our knowledge the only supply of real imported Geissler tubes in the country. To say this is an unusual offering is putting it mildly. These tubes are of the fluorescent liquid type only and the colors they show and the effect they produce when run on even a half-inch spark coil or a static machine is certainly beyond words to express. **Remember — this is the only stock in the country and no more can come in until the war is over.** The colors and shape vary in each tube, so that hardly two are alike.

No. 1128A, Fluorescent Liquid Geissler Tube, Length 11½ inches, sh. wt. 2 lbs. - - - **$1.25 each**
Only 362 on hand. If sold, money back.

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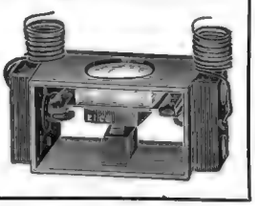
Everybody has read about the experiments of Telephotography (sending photographs over a wire hundreds of miles) made by Professor Korn and others. It is also known that if the problem of tele-vision is ever solved, the selenium cell will play an important role. Our Selenium Cell is the one used by all prominent experimenters. This cell has been imported by us for years, previously to the war. We have only a limited quantity on hand now and will not be able to get any, until the end of the war.

We guarantee every cell.

Imported Selenium Cell, each, shipping weight, 4 oz. **$10.00**
Only 48 on hand. If sold, money back.



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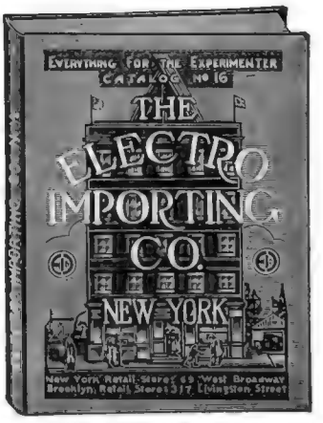
It contains the largest assortment of Wireless and electrical experimental apparatus shown in any catalog published. In addition are shown Commercial Wireless Sending and Receiving Outfits, Electric Motors, Dynamos, Flashlights, Medical Batteries, High Frequency Apparatus, Plating Outfits, Toys, Printing Presses, Tools, Sporting Goods and the LARGEST Scientific Book section published. This book will give you as much information as many books that cost you $1.00 or more. It contains 658 illustrations, 2,000 articles, complete Code Chart of Morse, Continental and Navy Codes, sixteen-page "TREATISE ON WIRELESS TELEGRAPHY," list of Call Letters of U. S. Government and Commercial Ship and Shore Wireless Stations, besides a great many useful tables and formulas. This valuable book is 7 x 5¼ inches in size and ½ inch thick, and well bound.



Size 7x5¼"--2000 Articles

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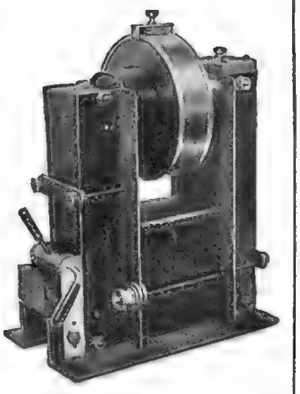
WIRELESS TRANSFORMER

A new perfected type, with even greater range, power and flexibility than our former model. Exclusive Variable Shunt and Ampere Scale give wonderful accuracy. Comes completely assembled—no chance for mistakes or burn-outs. Five sizes, from ½ to 2½ kw., 10,000—20,000 volts, any cycle desired.



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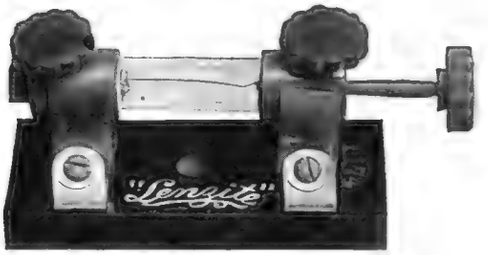
TRADE-MARK LENZITE

Recognized by leading authorities as the most sensitive and most effective Detector existing. If not satisfied, return same and money will be refunded.



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Write for booklet and further information to

Price complete $5.00

LENZITE CRYSTAL CORPORATION

537 Chamber of Commerce Building **Pasadena, California**

QUESTION BOX.

(*Continued from page 589*)

Q. 2. What capacity are each of the three variable condensers shown on the right hand side of the diagram? Begin with the upper one.

A. 2. We again publish complete circuit in which we give full details as to the size of the condensers used and data on the inductances.

Q. 3. What sort of coils are L8 and L9? Are they a loose coupler with a secondary and a primary, or do they remain stationary at a certain distance apart?

A. 3. The inductances L8 and L9 are inductively coupled and both coils are connected in series as in the diagram. The complete inductive coupler can be obtained by employing the secondary and primary of a loose coupler. However, it is advisable that you should use two coils wound with the same wire.

CURRENT CONSUMPTION.

(668.) James Green, Jr., S.C., asks as follows:

Q. 1. Is there any formula by which one can figure the current in volts and amperes that a 1" spark coil or a ½ K.W. transformer draws?

A. 1. The simplest rule which you can use for determining the amount of current and voltage that a 1" coil consumes is that which depends entirely upon the construction of the transformer, that is to say, some coils have a larger number of turns than others, consequently consume less current than the others, but at the same time producing the same effect due to the fact that the total magnetic flux generated by an electric magnet depends upon the number of turns and the current squared. Consequently either factor can be varied to give the result desired; thus by increasing the number of turns the current is decreased and vice versa.

Q. 2. When a transformer is rated at 110 volts and 5 amperes, does it mean that the transformer can run on this current, or that it draws that much with key depressed?

A. 2. Whenever a transformer is rated ½ K.W. it means that it will consume 110 volts and 5 amperes. The additional 50 watts which it takes represent the losses inherent in the transformer which is accounted for eddy currents and hystereses.

ELECTROLYTIC RECTIFIER.

(669.) J. G. Chaffee, Conn., inquires as follows:

Q. 1. Can an A. C. arc be used in wireless telephony? If not, why not?

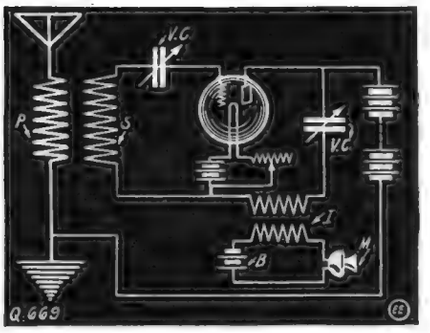
A. 1. An alternating current arc can successfully be used for radio telephony providing that the voltage across the arc is high enough to keep it burning constantly. A very good method which has recently been employed by several prominent engineers about the country is that involving a high tension transformer giving say about 14,000 volts as secondary potential and connecting it across an ordinary carbon arc shunted with a regular oscillatory circuit comprising a variable capacity and fixed inductance. It is then possible to use the alternating current arc as a generator for high frequency current as used in radio telephony. The modulation of the oscillatory current is controlled in the ground circuit. It is impossible, however, to use an alternating current arc which is connected directly to 110 to 220 volts alternating current mains, as the voltage of an alternating current at such low potential is unsteady, thus causing the arc to flicker, consequently not permitting the oscillatory circuit to have a chance to build up the high frequency currents.

Q. 2. What is the maximum output of a 4 jar electrolytic rectifier used on 110 volt, sixty cycle A.C.?

A. 2. The maximum output of a 4 jar electrolytic rectifier is about 40% of the input.

Q. 3. Can the de Forest type T tubular Audion bulb be used to transmit a wireless telephone message? If possible please give hook-up.

A. 3. The de Forest type T Audion bulb can be used as a generator of high frequency current for radio telephony providing a proper connection is employed and the diagram herewith gives one of the latest connection schemes for a radio telephone employing a tubular Audion.



Hook-up for Using the "Audion" as a Radiophone Generator and Transmitter.

LIGHTING QUERIES.

(671.) Walter H. Lombard, Southbridge, Mass., wishes to know:

Q. 1. Can a residence be lighted with 30 volt A.C. lamps for your residence by emcuit, by putting in a transformer to reduce voltage to 30 volts?

A. 1. You can satisfactorily operate 30 volt A.C. lamps for your residence by employing a step-down transformer in the 110 volt line circuit. We suggest, however, that you should use directly the 110 volts as a certain amount of loss is encountered in the transformation between the 110 and 30 volts.

Q. 2. Would lighting be as satisfactory if same candlepower bulbs were used as 110 volt service, and how would cost compare?

A. 2. Lighting would be satisfactory if you would use the bulbs having the same candlepower as that used on 110 volts. Larger size conductors are necessary, however, to care for the increased current.

STORAGE BATTERY.

(672.) Francis Ziesse, Bronx, N.Y.C., wishes to know the following:

Q. 1. What size wire is used to wind a loose coupler with a diameter of 6 inches and 18 inches long. Also how many layers.

A. 1. The primary should be wound with a single layer of No. 20 B. & S. copper magnet wire and the secondary should be wound with No. 24.

Q. 2. What causes a storage battery to lose its power at certain times and only able to regain it when shaken?

A. 2. The only reason that we can deduct that would cause the inoperative action of the storage battery when kept still is that it may be due to the gas bubbles formed on the positive plates of the storage batteries which causes a considerable increase of resistance between the negative and positive plate. This would reduce the current considerably, in fact, to nil, and by shaking it up, the gas bubbles are broken

(*Continued on page 597*)

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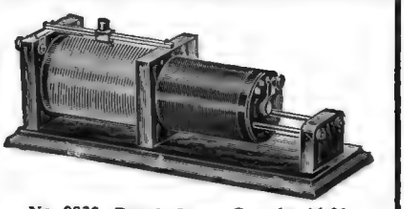
In War or Peace
Use Bunnell Apparatus



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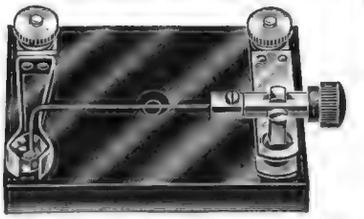

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On Dark Porcelain Base . . . $1.25
On Handsome Composition Base . . . 1.50

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Radio Dept.
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Nauen, Germany
to
Pittsburgh, Penn.

Undamped signals were recently received over this great distance by the DHE Station at Pittsburgh, Penn.

Holtzer-Cabot RADIO PHONES

were used. Nothing special; simply our Standard Set, no amplifying device in circuit.

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THE NEW TUBULAR MICA CONDENSER

Composed of a special mica possessing infinitesimal leakage. Its efficiency permits use across your tuners in place of massive load coils, to raise wave. Use in place of your present fixed condenser and note quality of tone and amplification. Made in two capacities, one capacity for grid of audions and tubular detectors, and one for crystal detectors. Individual capacity marked on same, tested from standard furnished by Bureau of Standards. Specify purpose. A high efficiency, beautifully finished permanent condenser, guaranteed. **Postpaid $2.50 Each.**

MONOTONE
IMPROVED QUENCHED GAP

Are you a leader or follower in adopting up-to-the-minute efficient apparatus? Equip your station with the famous MONOTONE IMPROVED QUENCHED GAPS, which are a big improvement over the original MONOTONE GAP. Span that freak distance on powerful waves of RADIO ENERGY. Each plate carefully machined. Best mica. Adjustable. One unit of the new gap for spark coils up to 3". One unit for every ¼ K.W. power of transformer. Specially recommended for powers below ½ K.W. Parts nickled and polished. You will be pleased with this new gap. Guaranteed. **Postpaid $2.50 Each.**

THE RICHARDSON CO., Manufacturers of Radio Apparatus ERIE, PA.

TURNEY'S PAGE

By glancing at this cut you can almost feel the real comfort this head set affords

Patent Applied For
ULTRA SENSITIVE
PRICE $7.50
Mailing Weight One Pound

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THE NEW TURNEY HEAD SET

With Adjustable Pressure Head Band

The peer of them all
Four new features
Three thousand ohms
Flexible back support
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No screws to catch the hair
German silver head band
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Soft, clear tone
Weight nine ounces
Can you beat it?

Dimensions, 2¼"x1⅞"

CRYSTALOI DETECTOR

Over 10,000 Sold

Never in the history of wireless has any single wireless instrument made such a phenomenal record as the **Crystaloi.** It is sensitive, permanent and handsome. Adjustment is made by turning the wheel. Every station should include a **Crystaloi** as a standby.

Type O $3.50 **Mailing Weight One Pound**

Dimensions, 4"x3½"

CRYSTALOI DETECTOR

Type AA

In the Type AA you have a super-sensitive detector that has made a remarkable record. This type contains a stepped-up cohering inductance which causes it to be at least 25% more sensitive than the Type O. It is a real beauty, will last a lifetime and is thoroughly guaranteed. You can't go wrong with this instrument.

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Dimensions, 2¼"x2½"

TURNEY CONSTANT AMPLITUDE TEST BUZZER

Over 12,000 Sold

Non-resonant dilectric case, 500-cycle tone, three binding-posts, beautifully finished and like all Turney apparatus, delivers the goods. Order one now and eliminate buzzer troubles.

Price $0.75 **Mailing Weight One Pound**

NOTICE—Send five cents in stamps for our miniature catalog containing full information of the above instruments and other wireless goods

Eugene T. Turney Company, Inc., 2595 Third Avenue NEW YORK CITY

QUESTION BOX.

(*Continued from page 595*)

up, thus decreasing the internal resistance which generates the power again.

Q. 3. What is a hot wire ammeter used for?

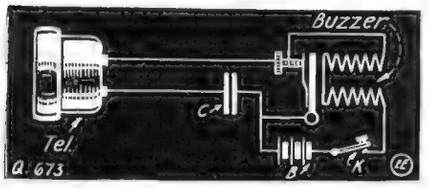
A. 3. A hot wire ammeter is used for determining the amount of current generated in an oscillatory or other circuit. It reads correctly on D.C. or A.C. circuits.

BUZZER SHOCK.

(673.) A reader of Tuscaloosa, Ala., writes as follows:

Q. 1. Explain how a bell or buzzer acts as an induction coil in that it gives a shock when the grounded binding post and the adjusting screw are used as secondary terminals.

A. 1. The only way we can explain this is that, the sudden excitation and sharp demagnetization of the magnet coils of the buzzer re-transforms the energy in it to pulsating current passing thru the hands of the operator, thus causing the shock. The spark produced between the terminals of the vibrator at break, and the current and voltage between them at a given time is very great; in fact, the potential difference in certain cases, climbs as high as 100 to 200 volts, depending upon the inductance of the magnet coils and the rapidity of break. The sudden counter electro-motive force of the magnet coils discharges into the vibrator terminals and it is this that causes the shock to the operator. It is



Radio Code Teaching Circuit Comprising Ordinary Buzzer, Small Condenser and Phone

noticeable that the shock is not continuous, but is a pulsating one, proving that the current produced at the two terminals is not continuous. When the armature closes the buzzer circuit the self-induction current due to the magnetic field is opposite in direction to the magnetizing current. At "break" of the circuit the self-induction current is in the same direction as the battery current and adds to it. This latter induced current is of very high instantaneous value.

Q. 2. How may a buzzer, telephone receiver, and battery be connected so that the sound of the buzzer is heard in the receiver, as in the wireless test buzzer?

A. 2. The diagram herewith gives the connections of the apparatus you mention.

Q. 3. Will a 6 volt, 12-15 watt bell-ringing transformer operate a spark coil made to work on 2-4 dry cells? Will the Erector toy step-down transformer? How is this calculated?

A. 3. A 6 volt bell ringing transformer will operate a 1" spark coil. However, we suggest that you should not use this arrangement as the vibrator of the spark coil will not work steadily due to the alternating current operating the vibrator. It is impossible for us to give you the calculations for this, as considerable data is required on the dimensions of the transformer before we can give you the calculations.

DENTISTS' AMALGAM.

(674.) Huerton Bingham, of Gisborne, N.Z., asks:

Q. 1. Could you give me the substances and method of making dentists' amalgam? I wish to make some for fixing crystals as it sets fairly hard?

We Announce The New

"ALBANY"

Alternating Current

Volt and Ampere Meters

Designed especially for the transformer primary circuits in Wireless telegraphy.

Plain Open Scale
Black Figures on White Dial
Heavy Beveled Glass
Neat in Appearance

Finish—Nickel Front, with Black Insulated Base, Back Connected. Long Posts.

Dimensions—Diameter of Base, 3".
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Fully Guaranteed

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VOLTMETERS—0 to 125 Volts, A.C.—60 Cycles - - $8.50
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Multi-Audi-Fone - - - -	$18.00
With Special Head Set - -	23.00
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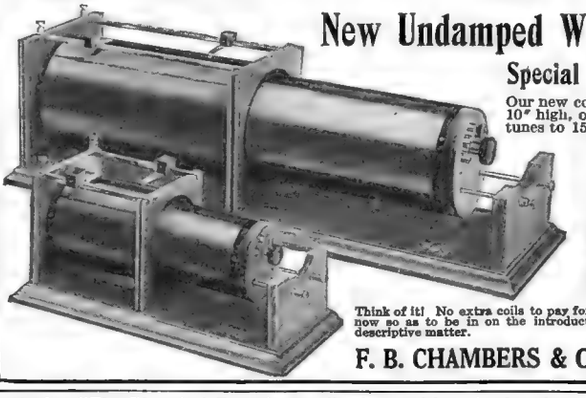

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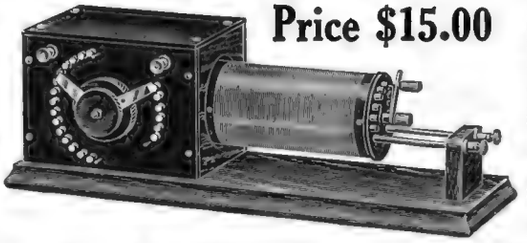

A customer said the other day: "Arnold, I have seen your Ad. in the magazine for months and had I known the instrument was as good as it is and looked so much better than the Cut I would have bought one sooner. I am glad I came to town and had a chance to take one in hand and see for myself."

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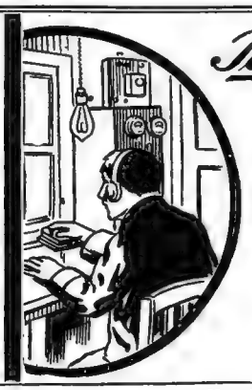

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The Packard Electric Company WARREN OHIO

Write Dept. EE

A. 1. The usual dentists' amalgam is made by dissolving chemically pure zinc metal dust in mercury. The zinc is placed in a glass receptacle and the mercury carefully poured over it. Only a few drops are necessary at first, until a thick mixture is obtained by the dissolved mercury and zinc. By adding more mercury the density of the mixture can be controlled.

Q. 2. Why do signals with a crystal detector come in strong and then fade away and then regain normal strength, and with an Audion sometimes stop for a moment?

A. 2. The phenomenon in your detectors cannot be accounted for, except that it may be due to the other apparatus you are using such as the aerial and loose coupler, variable condenser, etc. Sometimes a corroded or loose connection will give these peculiar operating characteristics in the receivers. Also on windy days, it may result from the swaying of the antenna. However, the main cause is generally from loose or unsoldered connections. We would, therefore, advise you to look over the connections and see that they are properly made with the instruments. If possible solder them to each individual instrument.

Q. 3. Is the crystal "Radiocite" advertised by the Electro Importing Co., a natural or artificial substance? If natural, what is it?

A. 3. "Radiocite" crystal is a combination of a natural and artificial product, the formula of which is at the present time kept a secret, and it is the result of a great deal of research work on their part.

CONVERSION OF A.C. TO D.C.

(675.) Frank Stigliano, of Wilmington, Del., asks the following:

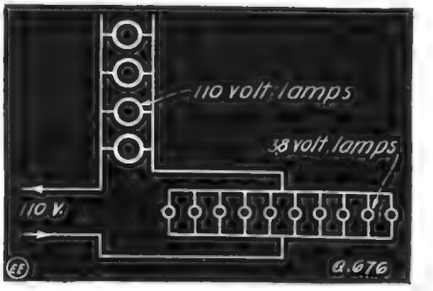
Q. 1. I would like to know if the A.C. current can be changed to D.C. with the mercury arc?

A. 1. We would refer you to the November issue of THE ELECTRICAL EXPERIMENTER and in the "Question Box" thereof you will find complete description of a mercury tube used for converting A.C. to D.C.

LIQUID RHEOSTAT.

(676.) Albert H. Beiler, New York City, wishes to know the following:

Q. 1. Will you please advise me of a suitable formula for a liquid resistance to be used as a rheostat and which will retain a constant resistance under all ordinary conditions. I have tried carbon electrodes in salt water and H_2SO_4; also various other electrolytes, but all of these vary their resistance when used for any length of time. I have heard that theaters use liquid rheostats with great success, by using certain secret formulae to make up their solutions. Do you know of any solution that will solve this problem?



Hook-up for Balancing Up a Number of Low Voltage Lamps with a 110-Volt Lamp Bank.

A. 1. There have been several formulae developed during the past for liquid rheostats and they depend entirely upon the amount of current which they are to regu-

(*Continued on page 601*)

Wireless Apparatus MESCO of Known Quality

MESCO Short Wave Regenerative Receiver

Recommended for relay work on wave lengths of 180 to 450 meters. It is possible to receive wave lengths up to 1,000 meters with reduced amplification.

The circuit is the Armstrong regenerative with constants accurately calculated for the wave lengths when employed in conjunction with audion detectors.

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Will increase receiving range of any station over 100 times.

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A blue print of connections with detailed instructions for setting up and operating this receiver is supplied with each instrument. Oak cabinet.

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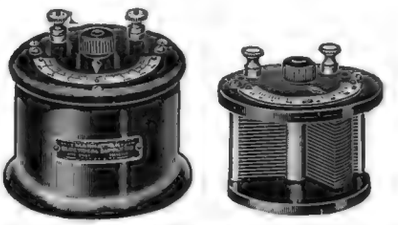

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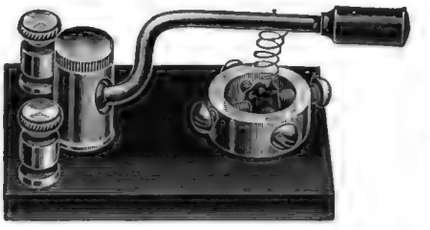

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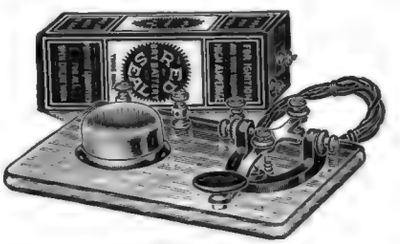

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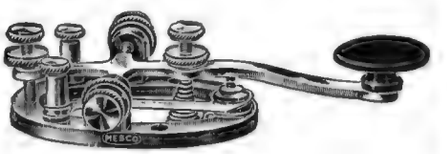

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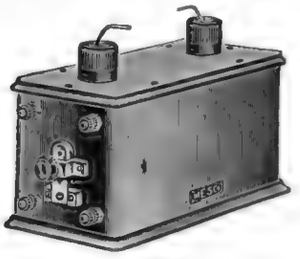
No. 452—N. P. Lever.....Price **$1.98**



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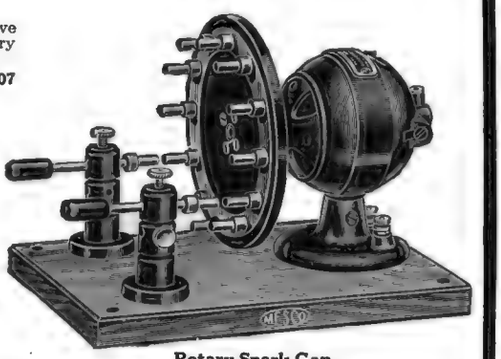

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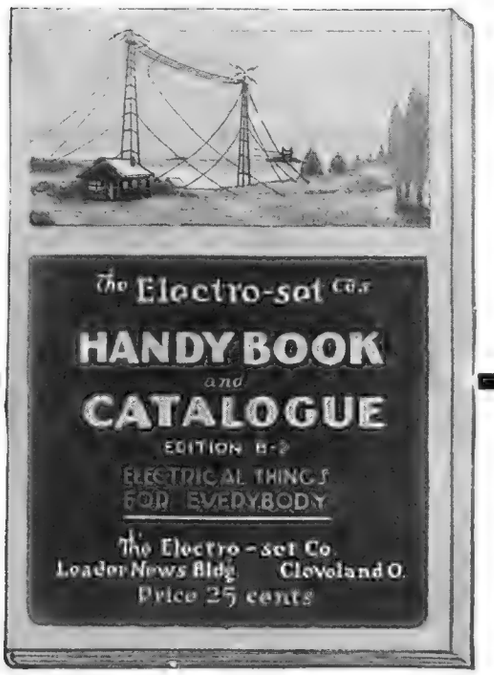

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QUESTION BOX.

(*Continued from page 598*)

late. For small currents say up to 2 K. W. of consumption by the apparatus, the electrolyte of the rheostat should be made of ordinary salt or sodium chlorid. In larger rheostats, the electrolyte used is a solution of either sulfuric acid or nitric acid. The density of the solution depends entirely upon the character of work for which the rheostat is used. The density averages in the neighborhood of 10% of acid to 90% of water. This proportion is universally employed where fine regulation of current is required.

There are no secret formulae for solutions used in liquid rheostats to our knowledge, and the ones above mentioned are those which are used generally and very extensively in laboratory work.

Q. 2. Do you know of any way in which a 110 volt D.C. may be used so that any number of small 3.8 volt lamps in parallel may be operated successfully by using a 40 or 60 watt lamp in series with the parallel combination. When about 30 small lamps are connected in parallel, the amperage of the resistance lamp is not enough to supply all of the small ones. Connecting them in series directly on a 110 volt line will partially solve the problem, but for the purposes required, a series connection is impractical.

A. 2. The only way in which you can operate 3.8 lamps on 110 volt circuit is to employ a suitable resistance in series with the line, thus reducing the voltage of 110 volts to that of the voltage required by the lamps.

If a resistance is not at hand, it is advisable to connect a bank of two or three 110 volt, 60 watt lamps connected on parallel in series with the line, thus making up the necessary resistance and thereby reducing the voltage to that required. It is advisable, however, that a variable resistance be used in the line as the proper voltage can then be obtained by merely changing the resistance of the rheostat.

You should connect the lamps as indicated in the diagram.

CONDUCTORS FOR CONNECTING RADIO INSTRUMENTS.

(677.) Lewis J. Cissna, writes as follows:

Q. 1. Will shellac injure or short-circuit a loading coil or tuner composed of enamel wire if it is put on it to hold it firm on the cylinder?

A. 1. Shellac will not injure or short-circuit the turns of the loading coil. However, it has been found that cheap shellacs have the property of absorbing moisture, thus increasing the conductivity between the additional turns and thereby reducing somewhat the inductance of the complete unit in all around work. Shellac and all other varnishes tend to increase the distributed capacity effect and are best dispenst with. However, the amount of loss obtained by the use of shellac is, generally speaking, negligible. For accurate work, the wire should be wound on a threaded form without the use of shellac.

Q. 2. What kind of wire is the best for connecting up radio instruments for sending and receiving?

A. 2. The receiving apparatus should be connected with flexible stranded conductors and all connections should be properly soldered to the various instruments.

The transmitting apparatus should also be connected with stranded conductors of considerably larger diameter than that used in receiving. Also, the insulation should be of such thickness that no leakage is apparent when the transmitter is in opera-

(*Continued on page 603*)

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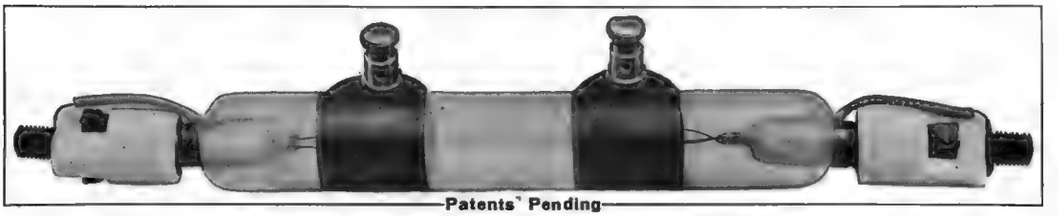

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Detector and Oscillator By wiring up one end for the reception of damped waves and the opposite end of the tube for undamped waves, rendering your set serviceable for the reception of both mentioned waves by a mere turn of a switch.

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QUESTION BOX.

(*Continued from page 601*)

tion. Modern transmitters employ ordinary copper strip connections which are not insulated, in the true sense of the word, but they are insulated from surrounding objects when they are used in the station.

Q. 3. Would lightning be apt to hit my lead-in wire which is 35 feet long and composed of No. 18 B. & S. gage wire?

A. 3. It is impossible to say whether the lightning will hit your lead-in as the freakish phenomena of lightning are such that it is impossible to foretell the dangerous effects that lightning may have. In order to properly guard against it you should always use a lightning switch in your station.

BOOSTERS AND WIRING SYSTEMS.

(678.) John Shelly of St. Louis, Mo., asks:

Q. 1. Explain the use of a booster?

A. 1. When a number of feeders run out from a station, the longest and those carrying the heaviest loads will have so much drop on the line that the pressure at distant points is too low. It is, therefore, necessary to raise the pressure to compensate for the voltage drop and this is done by inserting a *booster* in the circuit.

Q. 2. Is a three wire system desirable with an isolated plant?

A. 2. It is more expensive to install than the two wire system as it is necessary to add a balancer in connection with a 240 volt dynamo. This balancer set should have about one-tenth the capacity of the plant. Such an equipment has its advantages when 240 volt motors and 120 volt lamps are connected to the system. With this plant no changes in the motors are necessary, whereas in a straight 120 volt system, the motors would have to be changed from 240 to 120 volt machines.

TELEPHONE CONNECTION.

(679.) Russel E. Bathrick, Minneapolis, Minn., wishes to know:

Talking Circuits for Two-Party Telephone Line with Induction Coils.

Q. 1. Would like to have a hook-up for a two-party telephone line.

A. 1. Wiring diagram of a two-party telephone line is given herewith.

Q. 2. How many dry cells will it require?

A. 2. Four dry cells.

RADIO TRANSMITTER QUERY.

(680.) W. J. Murrow, Savannah, Ga., asks the following:

Q. 1. What would be the transmitting range of a station using a 12" spark coil or a 1 K.W. open-core transformer, both of Chambers make, with an aerial 100 feet high and 300 feet long, with condenser, etc., at this place.

A. 1. You should have no trouble in transmitting 150 miles with a 12" coil or a 1 K.W. Transformer with the aerial which you mention in your letter under good atmospheric conditions.

Q. 2. What is required for a receiving set and a transmitting set to receive about 5,000 miles and to transmit 1,000 miles? What instruments are required?

A. 2. To receive 5,000 miles you should employ the following instruments:—Loose Coupler, two variable condensers, fixt

(*Continued on page 605*)

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Just out, describes all the locomotives, the many passenger, freight and street cars, switches, semaphores, *everything*. Also a trip through the wonderful Lionel factory. *Free*—send for it, *then order from your dealer.*

BOY'S CATALOG FREE

SHOW YOUR FRIEND PAGE 621
Look at it yourself—NOW!

WIRELESS TELEGRAPHY
Make your own "Wireless," also Dynamos, Batteries, Motors, Telegraph, Telephone, Lights, Bells, Alarms, Coils, Current Reverser, Electric Engines, etc. Book with 75 Illustrations; by experts so anyone can understand it. With Catalog. All 10c, 3 for 25c p.p.
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EXPERIMENTERS!

6WT8

Save money by buying a GOOD storage battery FIRST. The ONE thing you can't afford to experiment with is a storage battery.

MARKO STORAGE BATTERIES

Marko Storage Batteries are especially adapted for operation of all kinds of spark coils, insuring a heavy and powerful spark. There is nothing superior

FOR AUDION USE

It is a well-known fact among up-to-date wireless engineers and experimenters that the Audion operates at a higher efficiency when controlled by a storage battery that gives constant voltage. Marko Batteries are designed to meet these conditions.

Marko GUARANTEED Storage Batteries are not experiments—they have been on the market for 10 years.

Guaranteed highest quality and lowest prices. Some Popular Sizes.

Type	Volts	Amp. H.R Capacity	List Price	Special price to wireless engineers
4C2	4	40	$ 7.00	$4.20
6C2	6	40	10.00	6.00
6C4	6	60	12.00	7.20
6C6	6	80	16.00	9.60

MARK O' QUALITY

Storage Marko Battery

PAUL M. MARKO, 1191 Bedford Ave., Brooklyn, N. Y. The Mark-o' Quality
New York Depot—974 8th Ave., New York City

READ THESE LETTERS ABOUT THE RADIO HEAD SET THEY ALL LIKE BEST

Strength and Tone

Battle Creek, Mich.
I received your phones and will say that I have found them all you claim. Have worked them along with phones costing considerably more and found that they excelled in both loudness and tone.

(Name on Request)

Increased Audibility

Pittsburg, Pa.
I had a well-known make in my station previous to this purchase and thought I was getting strong signals. I was greatly mistaken, and find your phones increase the audibility twofold.

(Name on Request)

They are samples of the letters we are receiving constantly from wireless operators everywhere—both amateurs and professionals. Many of them are experts who have tested different makes against each other before making their decision. All agree that for *strength, quality of tone,* and *ability to bring in weak signals sharp and clear,* they have yet to find the equal of the

Stromberg-Carlson
RADIO HEAD SET

Our new Improved Type A-9723 is wound to 2000 ohms, and furnished with drawn aluminum receiver cases, german silver head bands with universal ball-joint adjustment, waterproof cord and laminated pole pieces.

Price $8.25 at your dealer or direct from us

TEN DAY TRIAL OFFER: We sell this beautiful instrument with the understanding it will increase the receiving efficiency of your station regardless of the make of Head Set you are now using. If at the end of Ten Days it has not done so, or if you are in any way dissatisfied, send it back and we will refund your money immediately and without question. This ten day Trial Offer applies whether you buy from your dealer or direct from us.

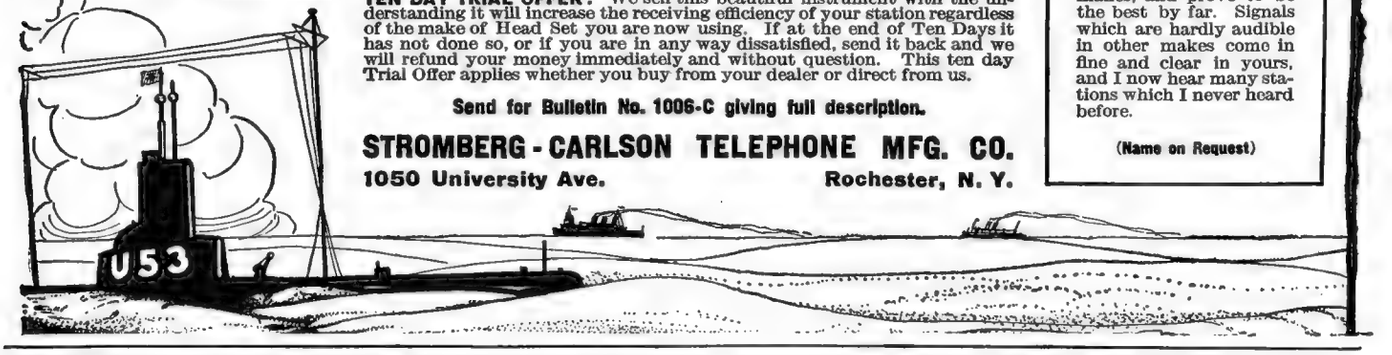
Send for Bulletin No. 1006-C giving full description.

STROMBERG-CARLSON TELEPHONE MFG. CO.
1050 University Ave. **Rochester, N. Y.**

Clearer Signals

Alameda, Cal.
Your receivers have been tested out against other makes, and prove to be the best by far. Signals which are hardly audible in other makes come in fine and clear in yours, and I now hear many stations which I never heard before.

(Name on Request)



MIGNON SYSTEM

SUPERIOR MIGNON SYSTEM RADIO APPARATUS

THE LAST WORD IN RADIO ENGINEERING

Mignon Adjustable Disc Core Undamped Wave Receivers

RW 1, RW 2 and RW 3

THESE RW TYPES (latest Mignon invention) are entering a new field in Radio Engineering, eliminating the so familiar Loose Couplers and Loading Coils. These late types introduce adjustable special metal disc cores, heretofore considered absolutely impossible. These new undamped wave receivers are the most efficient apparatus constructed at the present time, regardless of price and manufacture.

Write for Catalog R7 and mention E. Ex.

MIGNON WIRELESS CORPORATION, ELMIRA, N. Y. U. S. A.

QUESTION BOX.

(*Continued from page 603*)

condenser vacuum detector, vacuum amplifier, 3,000 ohm 'phones, loading coil and a large antenna which may consist of a single wire 600 feet long and about 75 feet high. You should have no trouble then in receiving stations 5,000 miles away from your station.

About a 5 to 7 K.W. Transformer is necessary to cover the range which you desire to transmit. In addition to the transformer of course it is necessary to employ the regular high-class auxiliary apparatus such as high tension condensers, oscillation transformers, etc., in connection with a suitable antenna in order to obtain maximum results. It is very important to have the sets tuned properly so that a maximum radiation should be obtained from the antenna.

Q. 3. What would be the receiving length or range of a set of wireless instruments with the aerial length and height as above with an Audion detector and amplifier combined, using storage batteries of the proper voltage for the detector and with a 15,000 meter wave tuner, a good pair of 'phones, etc.

A. 3. You should be able to receive 3,000 miles with the apparatus you mention and with the aerial cited.

RADIO CURRENT FORMULA.

(681.) Alex. Jablonsky, Keokuk, Iowa, wishes to know:

Q. 1. Give me a formula for calculating the amount of current, I_s which the transmitter needs to generate to give a certain amount of current I_r in the receiving station.

A. 1. The formula herewith given is the one you should employ.

$$I_r = \left[I_s \frac{150}{10^6 \lambda \text{ (meters)} \times d \text{ (miles)}} \right]^{\epsilon} \frac{h_1 h_2 \text{ (feet)}}{\sqrt{\lambda}} \frac{-.088\, d}{}$$

It is founded on the researches of Dr. W. L. Austin. Later this formula has been modified by Kimura. It is this formula that we give instead of Austin's, as it is somewhat simpler to use in calculating the complete equation.

Q. 2. Also give me formula for obtaining the amount of radiation from a given station.

A. 2. We would advise you to refer to the "Radio Section" of our November issue for data on this formula as an extensive article was published in that issue describing it quite fully.

PROTECTIVE RELAY OPERATION.

(682.) Jack Adonis, Saratoga, N.Y., wishes to know how protective relays operate.

A. 1. They act in combination with automatic circuit breakers, operating when their predetermined setting has been reached, energizing the trip coil of the circuit breaker and thus opening the circuit.

RADIO CONNECTIONS.

(683.) R. H. Buvick, Atlanta, Ga., asks:

Q. 1. Please publish a diagram showing the method of connecting the following instruments for the reception of undamped waves:—1 RJ8 Audion detector with tubular bulb, 1-4000 meter receiving transformer, 1 long wave loading inductance and 2 variable condensers. I should like to avoid if possible changing the internal connections of the Audion detector.

A. 1. Diagram herewith gives the connections of the instruments you mention in your letter.

Q. 2. My antenna is situated on the roof of a ten-story hotel. What would be the safest and best way to ground it?

A. 2. The best way you can ground your antenna is to connect the lead-in with a

"THERE'S MONEY IN IT"

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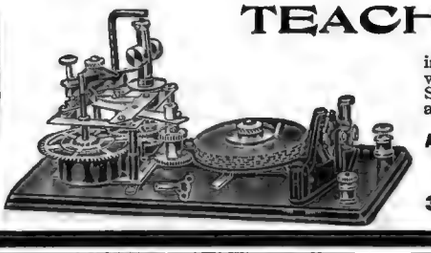
TEACH YOURSELF



in half the usual time, at trifling cost, with the wonderful Automatic Transmitter, **THE OMNIGRAPH.** Sends unlimited Morse or Continental messages, at any speed, just as an expert operator would.

Adopted by U. S. Gov't. 4 styles. Catalogue free.

OMNIGRAPH MFG. CO.
39L Cortlandt St. New York

Control the Cash Register of a Billion Dollar Business!

MEN ARE NEEDED to watch the profits of the Electrical Industry. These men must be trained—and if they are, big salaries will be paid to them. Electricity cannot be sold over the counter like ordinary merchandise. It must be measured by delicate meters—and the men who know meters and their operation are in big demand.

Big Salaries Must Be Paid

The Electrical Industry cannot afford to risk the care of its meters to untrained men. They pay big money to the men who know. These men must direct the staff of meter men—they rule supreme over the profits of a billion dollar business. No wonder their salaries are large. No wonder $150 a month is ordinary.

Men Are Needed Trained men are needed this very hour to guard the profits of the Electrical Industry. Meter Engineers—the men who know the science of electrical measuring instruments—are in big demand all over America. And you can qualify yourself to fill one of these positions. Just the kind of training you need may be yours right in your own home and, by spending a few hours in pleasant reading and experiment, fit yourself for one of these big jobs. Write at once—now.

Send the Coupon!

Put your name and address on the coupon, or on a letter or a post card now and get our new book on Electrical Meter Engineering absolutely free. Find out about the opportunities that await you. Find out how you can get this training right in your own home during your spare time. The book is free. No obligations. Write for it today. Opportunity is calling you and saying "Send the coupon."

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Gentlemen: Please send me your new book on Electrical Meter Engineering, absolutely free and prepaid. Also tell me how I can fit myself to "control the cash register of a billion dollar business." It is distinctly understood that I am under no obligations.

Name .....

Address .....

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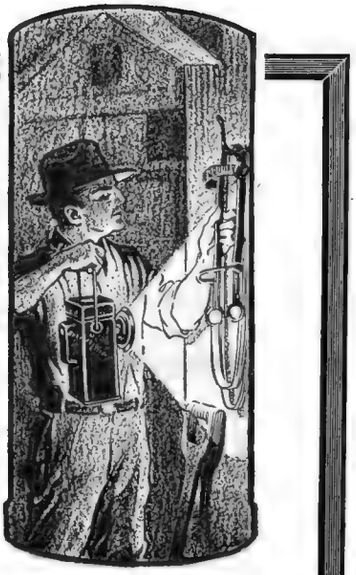


You Need a Good Flashlight

Along poorly lit streets, in dark hallways, or gloomy corners, a safe, sure, steady stream of brilliant white light is mighty handy.

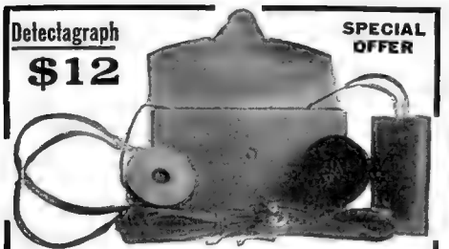
With a FRANCO Flashlight and a Radio Battery, there's no danger of starting fires, blowing up or blowing out — you get real flashlight efficiency.

Franco FRANCO Flashlights

and Radio Batteries are all definitely guaranteed. Made in seventy-five styles — you are bound to like some of them. Send for illustrated booklet and name of nearest dealer.

Interstate Electric Novelty Co.
104-114 S. 4th Street Brooklyn, N. Y.

Detectagraph SPECIAL OFFER
$12

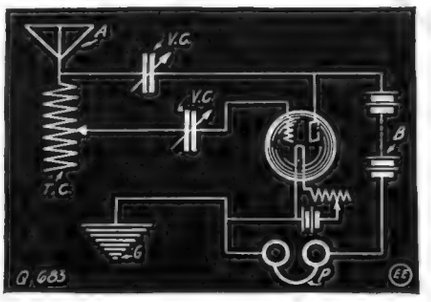


Our famous Micropho-Detectagraph is now offered at an extremely low price. This detecting instrument of marvelous sensitivity can be used for detecting secret conversations.
Outfit consists of Sensitive Transmitter and connector, 25-ft. Black Cord, Receiver, Headband, Case and Battery. The Transmitter weighs only two ounces. Price complete $12.00 for a limited number only.
MICROPHO-DETECTOR COMPANY
Gaston Boissonnault, Pres. 119-121 Nassau St., N. Y. C.
Makers of Detecting Apparatus from $12.00 to $250.00

100 ampere knife switch, the ground lead of which should be made of No. 4 B. & S. copper wire lead to the ground. This is the only way which you can ground it if you desire to have it passed by the Board of Fire Underwriters' inspectors.

Q. 3. I have a 4,000 meter loose coupler. Would it be necessary to load both the primary and secondary in order to receive long undamped waves?

A. 3. You should invariably use loading coils for both primary and secondary of



Connection for Vacuum Tube Detector Used for Receiving Undamped Wave Radio Signals.

your loose coupler in order to receive long waves from undamped wave transmitters.

RADIO INQUIRIES.

(684.) G. H. Harris, Macon, Ga., inquires:

Q. 1. Does a wireless station have to be inspected by a Radio Inspector and a Fire Insurance Inspector?

A. 1. It is advisable that the Radio and Fire Inspectors inspect your station, so that if any trouble arises later on, you are protected. The law, however, does not require an inspection.

Q. 2. If it does, how should you go about it?

A. 2. You should write to both the Fire and Radio Inspectors asking them to call to inspect your station. They will undoubtedly come and look the station over and advise you as to the different changes which may be necessary.

INDUCTANCE.

(685.) John Gorman, Kankakee, Ill., asks:

Q. 1. Please give me an accurate formula for calculating inductances.

A. 1. The formula you should use is the one developed by Nagaoki. This involves a factor which depends upon the length and diameter of the coil and the ratio "coefficient" values of which are taken from tables. We are unable to give this matter here due to its length and complexity. We would advise that you watch our forthcoming issues for complete details of the formulae for the measurement and calculation of inductances which we know will be of great service to you in the work you are pursuing.

Q. 2. What do you consider in figuring the efficiency of a rotary converter?

A. 2. The efficiency of a rotary converter depends entirely upon its size. In larger machines the efficiency is greater than that of smaller units. However, they range about 75 to 80% in machines up to 5 K.W. and less in machines of smaller size.

CABLE TO NANTUCKET.

A telephone cable was recently laid between the mainland and Nantucket by the Western Union steamer *Robert C. Clowry*. This cable will enable the residents of Nantucket to converse with any part of the country by long distance service.

STANDARD RADIO TERMS DEFINED.

Approved by the Institute of Radio Engineers.

Under this head we will define the most important radio terms each month. Save them and by pasting each in a book (properly indexed) you will have a handy radio dictionary.

1005. (b) *An auxiliary ship station.* Storage batteries are charged from the ship's mains, and operate a motor generator set or an induction coil. The over-all efficiency is the ratio of the kilowatt-hours supplied to the storage battery for a full charge to the kilowatt-hours delivered by the antenna circuit during the complete time of discharge. The energy ratio, rather than the power ratio, is here required, because of the method of storing energy in such batteries. It may be conveniently measured by the ratio of (kilowatt-hours on discharge of the storage battery to kilowatt-hours on charge) multiplied by the ratio of (power delivered in the antenna to power supplied by the storage battery to the radio equipment). This method is closely approximate.

1006. (c) *A land station.* High voltage alternating current (2,200 volts, for example) is supplied to the station from local power mains. This is stepped down to operate a motor generator set which supplies current of the definite type desired for the station. The over-all efficiency is the ratio of the power output of the antenna to the power supplied to the motor generator. If the step-down transformer feeds other electrical machinery or apparatus not a part of the radio equipment (e. g., lamps), the power supplied to such apparatus shall be subtracted from the total power supplied by the step-down transformer when calculating the over-all efficiency. If the motor generator in question is used to charge storage batteries which operate the station, an energy ratio, somewhat as in case (b) above, must be taken instead of the power ratio.

1007. (d) *A land station.* A large steam engine operates directly or indirectly an audio or radio frequency alternator which supplies current to the radio station exclusively. The over-all efficiency is the ratio of the power output in the antenna to the brake kilowatts of the engine driving the alternator.

1008. (e) *A land station.* A steam or gasoline engine drives a high voltage direct current generator which feeds directly or indirectly arcs or special gap dischargers in the station. The ratio of the antenna power to the brake kilowatts of the engine is the over-all efficiency (under similar conditions to those of (c) above).

1009. The *power output* shall be taken as the product of the total effective resistance of the antenna (not including the resistance of inductance coils, series antenna capacity, or switches and other equipment in the antenna), into the square of the current measured at a potential node.

1010. *Standard Antennas.* Two standard antennas are proposed; one for ships carrying sets of 2.5 kilowatts or under, and one for ships carrying sets of 2.5 kilowatts but not greater than 5 kilowatts.

1011. (a) SMALL ANTENNAS

Capacity=0.001 microfarad Inductance =50 microhenrys
Standard Test Wave Length=600 meters

Test Wave Length	Antenna Resistance
300 meters	8 ohms
600 meters	4 ohms
1200 meters	3 ohms
1800 meters	4 ohms

1012. (b) LARGE ANTENNAS

Capacity=0.002 microfarad Inductance= 30 microhenrys
Standard Test Wave Length=600 meters

Test Wave Length	Antenna Resistance
†600 meters	4 ohms
1200 meters	3 ohms
1800 meters	3 ohms
2400 meters	4 ohms
3000 meters	5 ohms

*At 300 meters a suitable series condenser will be inserted in the antenna circuit. The resistance of this condenser will not be included in the antenna resistance, since this condenser should be supplied with, and forms part of, the transmitting set.

†See note referring to 300 meters, above.

MARCONI NAVAL CAPTAIN NOW.

Guglielmo Marconi, the inventor, has been transferred from the engineer corps and appointed temporary captain of the navy.

AMPLITRON

New Vacuum Detector-Amplifier-Oscillator

Designed By **AudioTron** *Engineers*

Special Introductory Price $5.25

More Powerful Amplifier, More Persistent Oscillator than the AudioTron

This detector is of the two-member external control type and was originated by AudioTron Engineers last April. It has been developed and greatly improved since that date. This is its first public offering.

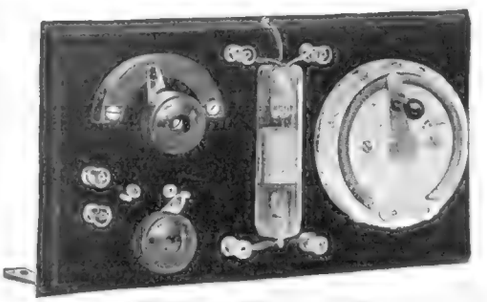
AUDIO TRON ALWAYS OFFERS GREATEST MONEY VALUE WHEN YOU BUY ON SPECIFICATION—NOT ON INDEFINITE DESCRIPTIONS

AUDIO TRON No. 1 Junior Receiving Panel

Orders mailed not later than December 10th will be shipped at these Special Prices:

Maple Panel finished in black imitation Bakelite. Potentiometer Control. All metal parts nickeled. Double Cut-Out Switch. Genuine double filament tested AudioTron.

Brackets for Table Mounting



No. 1 B Panel, Tube and 30 cell sealed B battery $14.85
No. 1 A Panel and Tube 10.50
No. 1 Panel only..... 7.00
Parts for Panel only.... 5.00

Fully Guaranteed

Shipped prepaid when cash accompanies order.

This High Grade Navy Coupler—$14.90 Delivered Free—on orders mailed before Dec. 10th

Quarter sawed oak, base and primary ends. Secondary end, primary panel and guide support hard rubber.

Metal parts nickeled.

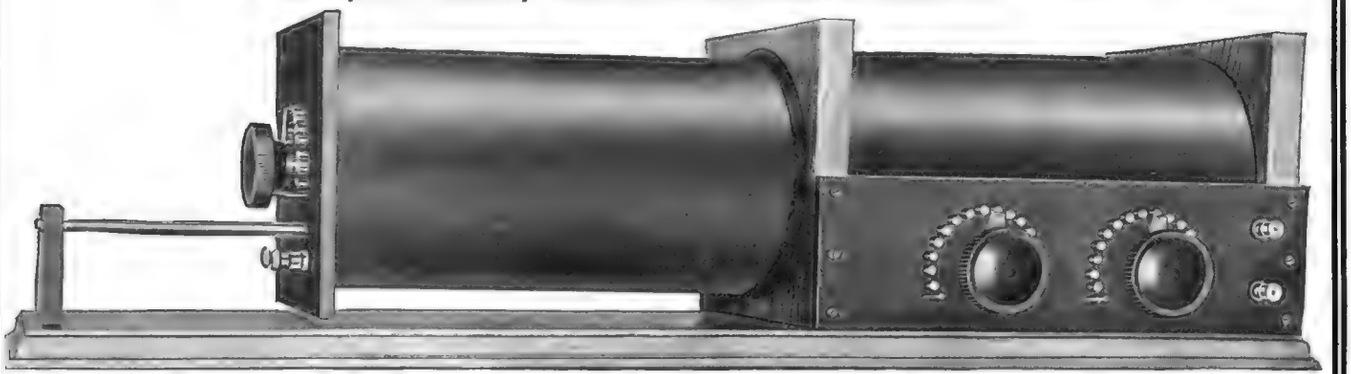
AUDIO TRON Navy Type Coupler, $17.50

Navy type bearing switches. Large knots. Fiber tubes, lathe cut. No enameled wire used. Windings covered with celluloid. Double guide rods.

Tunes to 3000 meters.

$32.50 AUDIOTRON 15000 M. ULTRA LOOSE COUPLER **$32.50**

Special Introductory Price on orders mailed before December 10th.



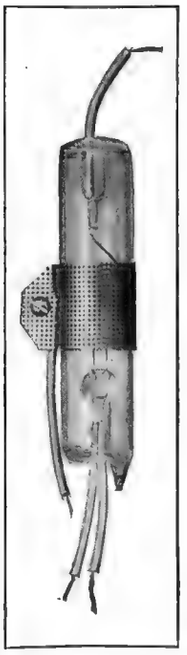
Embodies best features of commercial engineering practice. Quarter sawed oak base and primary ends, secondary end, primary panel and guide support hard rubber. Lathe-turned fiber tubes. No enameled wire used. 16 taps on secondary, 32 on primary. Navy bearing type switches. Large knobs. All metal parts nickeled. Windings covered with black celluloid, gives rich appearance and insures protection. Length overall, 36". Primary ends, 11" square. Double secondary guide rods. Guaranteed to tune to 15,000 M. The only high-grade long-wave coupler at any price. Regular price **$37.50.**

TERMS: Free Delivery where cash accompanies order. Satisfaction guaranteed.

AUDIO TRON SALES CO., 315 Lick Building, San Francisco, Cal.

The Moorhead Tube

Patent Pending



IS your detector perfect? Do you copy the German stations in daylight? Are you receiving signals from enormous distances? Does your detector keep its super-sensitive adjustment? Is it constant month after month? Do you copy the most distant signals through the heaviest strays and static? Is it the MOST SENSITIVE detector you have ever used? IF SO, you must be using the MOORHEAD TUBE. For this detector is guaranteed to do all of the above and more too.

It oscillates, it detects, it amplifies. And does all three better than any device you have ever used. Operative in any circuit. Reduces static over 50%, and has a life of over 1200 hours.

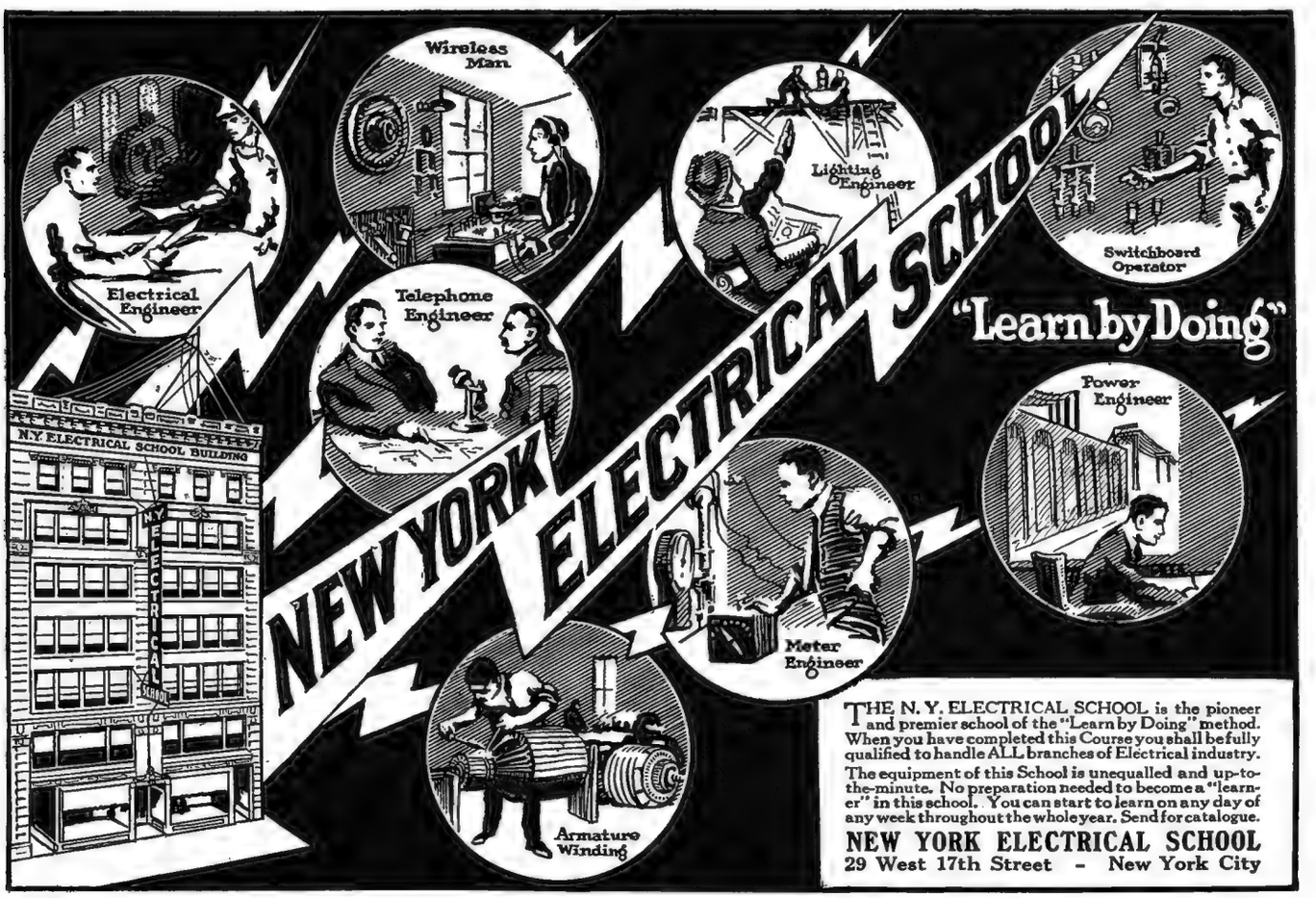
THIS IS OUR ABSOLUTE GUARANTEE

At a special introductory price **$6.50** Prepaid

Write for Our Circulars on Sets and Tubes

DEALERS: We have several Eastern dealers who are making good money on the Moorhead Tube, are you one of them?

PACIFIC LABORATORIES SALES DEPARTMENT
534 PACIFIC BUILDING SAN FRANCISCO, CAL.



THE N. Y. ELECTRICAL SCHOOL is the pioneer and premier school of the "Learn by Doing" method. When you have completed this Course you shall be fully qualified to handle ALL branches of Electrical industry.

The equipment of this School is unequalled and up-to-the-minute. No preparation needed to become a "learner" in this school. You can start to learn on any day of any week throughout the whole year. Send for catalogue.

NEW YORK ELECTRICAL SCHOOL
29 West 17th Street - New York City

EYES AND EARS OF THE DEEP SEA FIGHTERS.

(*Continued from page 550*)

possible?" you ask. Merely a possible adaption of common electrical devices already in use, to the special requirements of sub-sea navigation in mined and net-infested waters.

The apparatus might comprise a device for locating large metallic masses, such as battleships, a sudden rise in the bottom of the ocean or a sub-sea peak and to indicate when they are nearing shore. Second, an apparatus for determining when the submersible happened to approach small masses of metals.

Let us consider them in the above order. Referring to Figure we have the bow of a submarine. Mounted on the deck or under the water-line as desired, there is a huge siren or horn 2 or A^1, and two microphones, 3 or B^1; only one microphone being shown in either case, the other being on the opposite side. When placed on deck it may be swiveled and turned by means of the motor, 4.

It is well known that sound waves will be more or less reflected by any large body they strike; this phenomena is illustrated by the well-known echo. Also let us remember that sound travels at a certain definite speed through water.* Now, it is evident that if we send out a sound wave which is reflected and then measure the time and multiply by the velocity of sound we shall have the distance to the reflecting object.

Refer again to the figure. At A is seen a large dial with a pointer that travels over a scale graduated in feet. At B is shown a projecting handle By pulling down, then releasing B, it flies up. On the return it operates the siren 2 for a moment, and at the same instant releases the needle on dial A. As soon as the siren stops the microphones are switched automatically into the circuit by the action of B.

As soon as A is released, it starts to move over the scale at a certain rate of speed. When the sound wave reaches the microphones on their return, the current in them is varied, actuating the Audion amplifier, which energizes a magnet and stops the needle on A for a moment. It will be evident that with the scale of A, properly calibrated in feet, it is possible to read the distance to the object directly from it, since the distance around the scale it travels is dependent directly on the length of time consumed between the emission of the signal and its momentary halt upon the reception of the reflected sound signal by the microphones. The needle is stopped by the magnet controlled by the Audion long enough to obtain a reading before it continues on to the zero mark. The needle is driven by clockwork so arranged as to be kept wound up to the same tension by lever B, acting on the spring every time it is depressed.

The rheostat C regulates the strength of the transmitted signal; F controls the direction of the deck *eye*, the position of the latter being indicated by the dial M, thus the direction of the obstruction can be readily determined. If desired, the 'phones can be switched into the checking magnet circuit to assist in determining the distance to the object on scale A, thus giving a double check, both by noting the momentary checking of the pointer's movement and the sound in the 'phones.

The location of large objects being thus easily obtained it is a simple matter to avoid them, but in the case of nets and mines the reflection of sound waves is not great enough to show their presence.

We therefore take recourse to the oft-described and remarkably sensitive Hughes induction balance. Referring to sketch, we see the differentially wound coils, 5, fitting into a chamber. These coils are mounted on a rod 6, which connects with a disc that fits tightly into the cylinder 7. By allowing comprest air to enter behind the piston the rod is forced out and the coils are advanced some 30 feet in front of the craft proper; admitting comprest air in front of the piston, drives it back to the normal position.

These coils are connected to a similar pair located behind the main observation switchboard. The latter are wound in the same direction as in the usual balance as described in a previous issue of THE ELECTRICAL EXPERIMENTER. The coupling between the coils can be varied by means of the sliding handle E. Lever D controls the comprest air actuating the piston of the rod carrying the coils, 5; switch H allows the 'phones to be connected into the circuit with one pair of coils, switch G throwing current into the other set, the strength of which is varied by rheostat N.

The principle is self-evident. While in a mine field the coils S are extended and a balance obtained with lever E. When approaching a mine or net, which are large metal bodies, the precise magnetic balance is disturbed and a sound will be heard in the 'phones. Operating D draws the coils back into the chamber, placing the rudder hard over and full speed reverse prevents an actual collision.

The switchboard is placed conveniently near the wheel L, speed controller K, periscopes I and J and the bank of indicating devices necessary for the operation and control of a modern submarine such as here considered.

A commander equipped with this apparatus is, in accordance with my plans, therefore in a position to maneuver quite safely among the enemy mines and nets.

The objection might be raised that the siren would warn the enemy of the presence of the craft, or in case the method of detecting submarines previously described in this journal was in use, the submarine could easily be located by the enemy. In answer to the first objection, consider that the mere knowledge of the presence of a submarine does not constitute capture, especially so, when it can move safely through a netted district without being caught in it.

Secondly, the microphones on shore are tuned to pick up the high note of the motors and in case they succeed in locating it there still remains the difficult undertaking of capture.

That such a device would be valuable is not so very doubtful the author believes; at least it would seem to require a practical test to prove it a failure.

*The velocity of sound through water is approximately 4,000 feet per second. Hence, if the distance be 100 feet to a reflecting object, the time taken by the sound in traveling from the ship to the object, and from object to ship will be approximately one-twentieth of a second. This effect has been utilized in taking "soundings" or measurements of the depth of the sea in a very accurate manner as cited by Mr. R. F. Blake (Prof. R. A. Fessenden's work) in a paper presented before the American Institute of Electrical Engineers, at Philadelphia, Pa., October 12, 1914. The distance to hidden icebergs, even 2½ miles away, was measured in this way, also, and the results were very satisfactory. It should be mentioned that a special switching device or commutator must be used in such sound reflection measurements, which operates so as to enegize first the sound producer, and then to close the circuit to the microphone or receiving resonators in time to intercept the "echo." For an interesting account of the present type sound wave submarine signaling apparatus, carried by all first-class ocean-going steamships and warvessels the reader is refered to THE ELECTRICAL EXPERIMENTER for February, 1916. From these reports we find also that the deeper the submergence the better the results, for the surface water is not quite as good a conductor of sound. Also the velocity of sound will vary slightly with change in temperature and corresponding variations in density.

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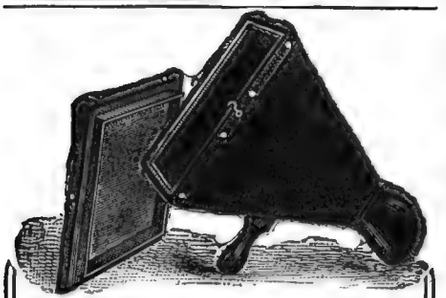

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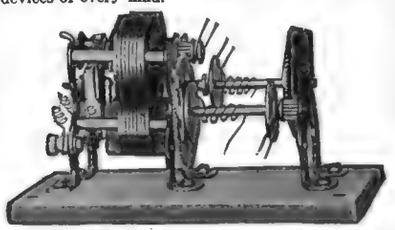

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THE ARLINGTON RADIO STATION.

(*Continued from page 571*)

kilowatt, 500 cycle *inductor* type generator.

100 Kilowatt Arc Set: The third set installed at Arlington is a 100 kilowatt, *arc* set, and shown in Fig. 6. This set consists of a suitable motor-generator, arc chamber, magnet poles, magnet coïls, inductances and necessary switch panels.

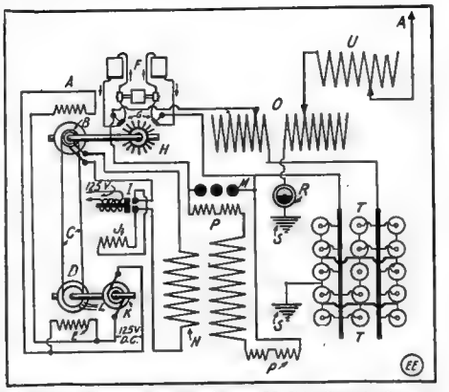

Fig. 4. Connections of 100 K. W. Spark Set at Arlington Radio Station.

The motor-generator embodies a 160 horsepower, 3 phase, 25 cycle induction motor, and a generator rated at 500 volts direct current and 100 kilowatts; both mounted on a common base and direct-connected. The motor shaft has an extension, whereby a pulley can be mounted and the set run by an engine or other prime mover by means of belting. The control for the motor is mounted on a switch panel and is controlled from a position near the arc by means of a small switch, which operates the contactors of the panel, starting the machine on low voltage and automatically bringing it up to full voltage as the starting current is reduced. This machine is brought up to speed in four seconds from the time the switch is closed. The wiring plan is shown in Fig. 7.

From the copper or positive electrode, a heavy lead is taken to the helix, and thence to the antenna. In series with the helix, is a smaller helix of twelve turns, giving a wave length change of about two hundred meters; and from each turn of this helix a lead is taken to a twelve point relay, which is operated by 110 volt direct current. The resulting action when the contacts are closed (which happens when the *hand key* is released), is that the wave is shortened by the twelve turns of inductance being short-circuited. When the hand key is pressed, as in operating, the contacts are opened, thus lengthening the wave. Thus there are two distinct waves sent out, one when the key is pressed, of say 6,000 meters, and the other when the key is released, which would be about 5,900 meters.

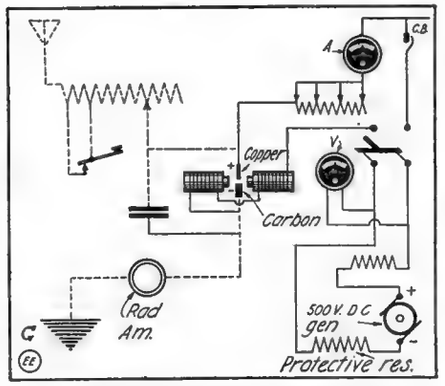

Fig. 7. How the 100 K. W. Poulsen Type Arc Transmitter at Arlington Is Connected.

From the negative electrode a lead is taken thru the hot wire ammeter, and then to ground. The operation consists in first striking the arc at reduced voltage, and by means of a finely threaded screw arrangement, bringing the carbon back, thus lengthening the arc, at the same time increasing the voltage by cutting out resistance. This operation is repeated until full voltage is on, when the length of the arc is regulated by watching the radiation hot wire meter, there being a maximum setting, from which opening or closing the arc causes a drop in the antenna current.—*Illustrations courtesy Proceedings Institute of Radio Engineers.*

THE DELINEATION OF INTERNAL ORGANS BY A NEW ELECTRICAL METHOD.

(*Continued from page 553*)

as seen by the bystander, is very unimpressive. There is no darkening of rooms, no flashing of lights, and no crackling of spark-gaps. In fact, the whole proceeding is so brief, and seemingly so simple, that when the results are observed the first sensation is one of bewilderment.

A patient is laid on a plain deal (wood) table (insulated by standing it on glass), a little clicking is heard in a cupboard hard by, and after sixty seconds or so the bearers are directed to remove him. Nothing has been felt by the patient, little or nothing has been seen by the bystanders beyond what has been noted, yet a visible record of the outline of a living organ has been conveyed to a wax sheet. This is then printed on ordinary photographic sensitized paper by the employment of methods already familiar in several other connections.

The Appliances Used.

If there is nothing impressive about the procedure itself, there is also nothing especially remarkable in the appliances employed. For the most part they are of quite a familiar kind. Some are kept in the cupboard mentioned, while the rest—namely, the electrodes and connected wires—are suspended in the room.

The main contents of the cupboard are seen to be two separate electrical batteries (Battery A and Battery B) of precisely equal strength, together with a means by which alternations in their currents can be produced and varied at will. The other contents include a revolving cylinder over which is suspended a needle hammer capable of side to side as well as up and down movement, the two together bearing a resemblance to a barograph. This cylinder carries a rolled sheet of paper treated with paraffin wax on which the outline of the organ under examination is initially recorded. The needle hammer mentioned is connected with a tiny circle of carbon like the diaphragm of a telephone machine, which is operated in its turn by a current detector capable not only of picking up and measuring, but also of concentrating currents too small to be convertible into force by any other means. The current in this particular case comes from the patient's body, arriving through a wire connected with one of the two electrodes.

There are two of these electrodes each of which ends in a perforated zinc plate or zinc wire screen, which is not placed in contact with the patient's body. One of these, hereinafter called Screen A, is about 18 inches broad by 12 deep, and stands vertically on a pedestal, which, being movable, can be put in the same plane as the patient's body and in its immediate vicinity.

The other electrode, Screen B, is about

(*Continued on page 618*)

DR. LEE DE FOREST—THIS MONTH'S SUPPLEMENT.

(*Continued from page 561*)

and in a commercial form. This first Audion differed in that it was not a rectifier but a genuine relay, a local current passing all the time through the telephone receivers, this current being decreased upon receipt of signals—apparently the exact opposite of the method employed in the Fleming valve. But before the two electrode Audion could be generally introduced Dr. de Forest invented the *grid* electrode, applying the high frequency oscillations to a third intermediate electrode instead of to the plate as in the preceding type. Every radio engineer knows the enormous advantages which the grid electrode introduced. It made possible the Ultraudion and the oscillating Audion as a source of power for transmitting purposes.

In 1911 and 1912 Dr. de Forest was Chief Research Engineer for the Federal Telegraph Company, in San Francisco, Cal. In 1912 rights to the Audion amplifier as a telephone repeater were purchased by the American Telegraph and Telephone Company. The Audion repeater is to-day used in every long distance telephone line extant. It alone made possible transcontinental telephony. The Western Electric Company manufactures these by the thousands now for telephone purposes.

Dr. de Forest in 1913, first demonstrated the oscillating Audion as a source of radio frequency current. The development of the *Oscillion* as a source of radio power has gone on from that day very rapidly. To-day it is possible to obtain a ½ K. W. or 500 watts of high frequency energy from a bulb but 6 inches in diameter and by this means to telephone wirelessly 300 miles. With 500-twenty watt *Oscillions* connected in parallel at Arlington recently the human voice was heard as far as Honolulu, T.H. There is no question that the *Oscillion* is destined to surpass all forms of the spark transmitter, so that in years to come the spark will be as obsolete as the one-time marvelous coherer of Marconi.

Dr. de Forest has taken out 85 United States patents on radio inventions and a large number of foreign patents.

One of his latest inventions is the use of the Audion for the production of musical frequency currents for producing sustained notes and for remarkable range of quality. It is predicted that an instrument surpassing the organ in beauty and flexibility will be some day produced on this principle.

UPS AND DOWNS OF A TELEGRAPH LINE.

(*Continued from page 566*)

had the idea that it was just an ordinary, nice, shiny wire, and we didn't disturb the idea in the least. We knew it was wrong, too, because we didn't have a poet's license; but it was so hard to get the permissions that we stretched a point. At that time the telephone and electric-light companies were saving money by using house-supports as far as possible; and a house in a popular location sometimes collected wires till it looked like a gigantic harp that had been through some sort of an accident; so people were getting shy of that wire-thing.

We strung our wire all in one afternoon, and went to the Kickapoo Indian show in the evening; that was so as to be out of the way in case any of the neighbors called with criticisms. Several of them did. They said our wire reminded them of the dump, or words to that effect, and we must remove it immediately—perhaps the next morning at sunrise would do. But a little delay turns away wrath almost as well as a soft answer does; and, after we had lain low for a few days, the neighbors forgot our outfit, or found something else which peeved them more. So the line stayed up and was opened for operation.

The business-end of our enterprise was an organization modestly called the "Continental Telegraph Company." It was fully officered, with president, vice-president, secretary, treasurer, general manager, chief inspector, and several minor positions. As there were only four of us in all, this arrangement gave us several offices apiece, which prevented any one's feeling slighted and gave each a chance to "boss" somebody. None of us would take any orders from another one, but a fellow as vice-president, for instance, could bully himself as chief inspector all over the lot; and on the other hand, if *he* went too far, he could turn right round and tell the vice-president what he thought of him and dare him to fire him.

The line did nothing but regular business at first, but, after a while, that grew stale. Then it was found that, by one means and another, the sounders in all four houses could be made to give forth a variety of novel noises and business was diverted in that direction. With a contact-spring resting on a ratchet-wheel, you could produce a rattle, buzz or squeak, according to speed—especially effective in the dead of night, when it woke not only your fellow-members, but their entire families, causing fathers to bellow up attic-stairs words signifying that the monkey-business must cease. A loose-contact, formed of two hanging weights lightly touching, was also admired—by its originator, nobody else. As his mother walked about the house, brewing doughnuts or making beds, the weights would jiggle together and send spasmodic stutterings down the line. From such crude beginnings, we progressed into clockworks carrying commutators which would send out a name, like "Alice" or "Mabel," hour after hour, till the cussed thing ran down—the name of some girl, you understand, that a fellow was supposed to be "interested in" but really wasn't at all, no sir, never so much as noticed the darn fool.

I'm free to confess that this deviltry wasn't confined to any one member. We all tried to be as annoying as we could, and we were some little annoyers, as fond teachers and a few selected neighbors could testify. But one imp of depravity named Dan had it all over the rest of us. Man alive, he would have had patient old Job himself chasing him red-eyed. Dan isn't his right name; it would be mean to tell it, because he has reformed and is real gentle now—at least, everybody thinks so but his wife, and she says he's worse than he used to be.

After every new breach of the telegraphic peace, we'd hold a meeting and pass a stiff by-law prohibiting that particular monkey-shine; and as a result of this Dan's inventiveness, our book of by-laws bid fair to rival in size the General Statutes of Massachusetts, which is a volume as thick as it is wide, and it's no narrow tome, believe me. At last, the bright idea struck us to compose a single law, on the lines of the Sherman Anti-Trust Act, which should be so broad that it would cover the use of any kind of "infernal-machine."

We did our best with that law. Dan, the chief offender, was just as interested as the rest of us, and helped to make it good and tight. When it was done, it didn't appear to leak a drop and we believed nobody in the world could think up any kind of hand or clockwork trouble-mixer that it wouldn't land on in a minute.

And that masterpiece of a law was no sooner copied into the book than Dan gave out that he had invented a way to beat it!

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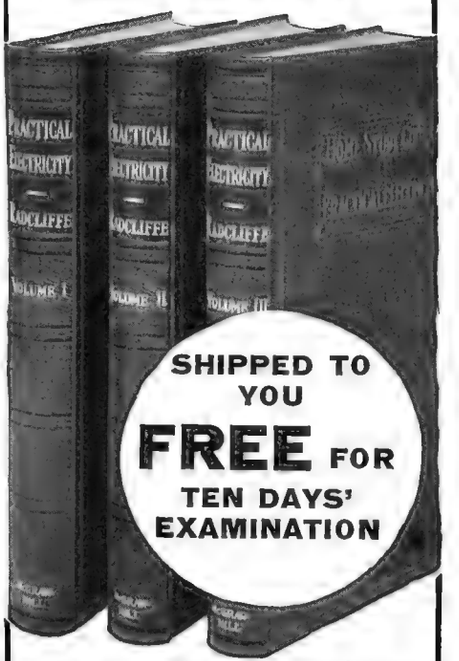

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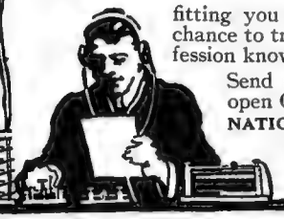

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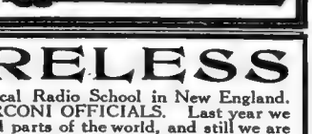

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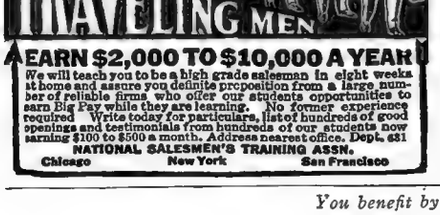

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Whether he had or not was a perfectly even bet, because he was as good a bluffer as he was an annoyer. We pooh-poohed his threat, of course, and dared him to produce his invention. He only shook his head and invited us to wait and see. Days went by, and deep peace brooded. It was almost too deep. The pep seemed to have vanished from the telegraphic world. Honest, we almost wisht we hadn't past that law.

Now, Bugs, the climax of this story is coming and I don't know whether to put the cart before or behind the horse in telling it. It's interesting either way, as the fellow said about the elephant, when he couldn't decide which was the head-end. On the whole, I'll vote for the cart-first, so I'll let you into Dan's sleeve and show you what he had up it.

Dan's house had lightning-rods on it—the ancient, twisted things once so familiar, which wobbled and sagged till their joints opened up good and wide. Hospitable old rods! they wouldn't hustle a lightning-bolt right through to the ground without even saying "Howdy-do." No, they made it welcome; they said "Stop a while; come on in the house and amuse yourself with the kitchen-stove and the baby and grandpa's false teeth till it stops raining.

Well, as far as Dan went, all his idea was to take a piece of wire and connect the top section of one of those rods to our line, figuring that, during the next thunderstorm, some new kind of a tickle, and maybe a spark or two, would go through—and he wouldn't be the one who was doing it, would he? So the law wouldn't apply. He was just going to make nature work for him.

When you take nature into partnership, however, you want to be sure that you're the head of the firm. Dan wasn't. Nature is some trickster herself and, further down the line, she had a contraption of her own that she thought would work in fine with Dan's. At that point an insulated electric-light wire had been strung over ours. Nature went to work on that light-wire, and by heat and cold and gravity-pull and wind-waving, stretched it till it lay on our poor old rusty, innocent line. Then she worked at it with friction till all the insulation was gone except a thread or two, and her little joke was all ready to spring. Just a spark from Dan's lightning-rod to start an arc, and the full-fledged dynamo-current was prepared to saunter into our happy homes and perchance start something.

It was a sultry night in August. The heat was the kind that makes you peevish with the sheet because it's so much hotter than you are, you don't know why—and probably the sheet is just as peeved with you for the same reason. A thunderstorm was grumbling gently, way off on the horizon. The Continental Telegraph Company, on its four separate beds, tost in a troubled half-sleep. (That's going great; sounds just like a chapter from "Myrtle Clayton, or Wrong from the Start.")

The storm crept nearer and nearer, blacker and blacker; but silently now, for it had something to do. The air cooled by degrees and, as it cooled, the sleep of the Continental Telegraph Company became more peaceful and profound.

Suddenly, I woke with a start. The lightning, having crept near enough, had pounced. An interval, and then another flash, nearer yet. The window was filled with dazzling light. There was a spark from the lightning-arrester on the instrument-shelf and the sounder gave an uneasy kick before the crash of the thunder came.

Lightning had nothing on me for speed in getting out of bed and into the hall. I peeked around the door-frame for further

(*Continued on page 615*)

PATENT ADVICE

Edited by H. GERNSBACK

In this Department we publish such matter as is of interest to inventors and particularly to those who are in doubt as to certain Patent Phases. Regular inquiries addrest to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are published here for the benefit of all readers. If the idea is thought to be of importance, we make it a rule not to divulge details, in order to protect the inventor as far as it is possible to do so.

Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

AMPLIFIER.

(109.) C. W. Halligan, Pennsylvania, sends us a drawing of a radio amplifier to be used in telemechanics. He wishes our advice if the device is practicable and if a patent could be obtained.

(A) The device in question would not work satisfactorily for the simple reason that a polarized relay is used in connection with it and we have not found a polarized relay as yet that can take the fastest "send" of an expert operator. Also, a device of this kind would obviously be of no use for radio telephony, and for this reason we can give but little encouragement to our correspondent.

STREET CAR INDICATOR.

(110.) W. Bethel, Indianapolis, Ind., has invented an automatic device for street cars to show the street approaching, and he claims that it can be easily reset in case car is obliged to take a course other than the regular one. It can be installed with little expense and can be regulated to show streets when leaving the last stop. The device is not worked from the track and is supposed to be weather-proof.

(A) We refer our correspondent to query No. 107, in which we stated our opinion clearly.

ELECTRIC COMBINATION.

(112.) Emil Moir, Hoboken, N.J., has submitted a very ingenious arrangement of an electrical combination, the idea being to complete an electric circuit from the different parts at different places. Two sliders are used to vary the combination and several other novel means are described to make the device rather effective.

(A) A device of this kind certainly can be patented. There might be a fair market developed as there seems to be a demand for an article of this kind. We would advise our correspondent to get in touch with a patent attorney.

AUTOMOBILE SIGNAL.

(113.) G. D. Ryder, Danbury, Conn., has an idea involving the use of a loud-talking telephone transmitter in front of an automobile, and by use of amplifying means to step up the voice in the horn which could be heard for some distance. He claims that anyone using this device can give warning to people in front and in back of the automobile; he wishes to know if the idea is practical and if a patent could be obtained on it.

The idea certainly sounds novel, but we doubt very much if it would come into general use by automobile owners. For one thing, the cost is against it. Also, devices of this kind are not too reliable. We do not think that a patent could be obtained on a device of this kind for the simple reason that merely using an article that has been upon the market for sometime, on an automobile, does not make it patentable.

PATENTED ARTICLE.

(114.) Charles Welsh, Philadelphia, Pa., would like to know the following: If a person has a patent on a certain article, can another person make that article for his own use?

According to the law, a private person cannot make and use, even for himself, an article that has already been patented. If the patentee finds out that another person is making and using an article on which he has a patent, he can stop him from using it. As a rule, however, it is very difficult for a patentee to do this as in the majority of cases, the patentee does not know who is using his patent for private use.

DRUM PROTECTOR.

(115.) Michael Frankovich, Anaconda, Mont., has devised a novel ear protector for protecting the ear drums from sound waves created by firing big guns. Our advice is sought on this invention.

This is a very good idea and if carefully worked out, a good commercial article should be produced from this invention, provided it can be sold cheap enough. An English company at the present time makes an ear drum protector, but it is the only one on the market as far as we are aware of. We think the idea of our correspondent is thoroly practical and believe that a patent might be obtained on it. Our correspondent also submits sketch of an auxiliary heater to be used on a kitchen stove, and he desires to know our advice on it.

Frankly, we do not think much of it, as it is very difficult to get more heat from a stove, simply by putting an attachment to it. Of course, in the present case, the radiating surface is increased, but we do not think that an expensive device of this kind would be practical from a commercial standpoint.

ROTARY TUNING COIL.

(116.) Frank Harrell, Jr., Tampa, Fla., has invented a rotary tuning coil and wishes to know if there is one already on the market. He wishes to know if it could be patented.

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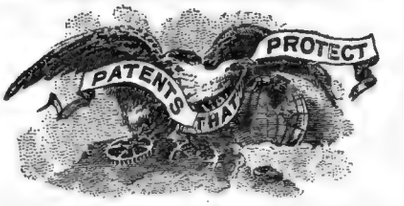

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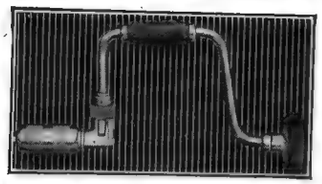

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A coil almost identical to the one submitted by our correspondent was published some years ago in *Modern Electrics* and later in THE ELECTRICAL EXPERIMENTER, a similar coil was published. While an article of this kind will undoubtedly work, it is too difficult to construct from a manufacturing viewpoint as the time lost in winding is entirely too great.

A "STOP" FOR PHONOGRAPHS.

(117.) C. Moffet, Colo., wishes to know if an automatic stop for phonographs is worth anything. He furthermore claims to have invented a new needle holder for phonographs which increases the volume of sound and improves the tone. He wishes to know if he should patent the idea.

As to the first idea, there are several automatic stops on the market now and not being thoroly familiar with our correspondent's device, we do not know if a patent could be obtained on it and whether it is of sufficient interest to sell the idea in case a patent were obtained on it.

As to the needle holder—without actually seeing what the article is, we cannot tell if it could be patented or not. There are a great many such holders on the market now and we would advise our correspondent to get in touch with a patent attorney and have a search made as to the patentability of the idea.

A PECULIAR THUNDERCLAP.

A writer in *Nature,* living at Aberdeen, Scotland, describes a peculiar thunderclap which occurred during a severe thunderstorm on July twenty-seventh. This parish lies in a hollow of the hills, and almost always escapes close contact with thunderclouds. On the date mentioned a peal of extraordinary suddenness, resembling the crashing burst of a big gun followed instantaneously a vivid flash at my point of observation. Two or three trees were afterwards observed to have been struck and a fence rail near some wire was split into pieces and thrown some distance. Now the peculiarity is this: that very similar experiences were noted at places more than a mile distant and in various directions. The same crash following immediately on the lightning was noted by quite a number of independent witnesses. A mile to the east of my dwelling the lightning was seen to run down a wire fixed to the top of a flagstaff. About a mile to the north a farmer driving home was alarmed to see the lightning flash along the wire fencing by the roadside and split one post at least and cast the fragments on the road.

On considering all the circumstances, I think the following may be an explanation: The thunderclouds which contributed mostly to the storm were floating at a pretty high elevation, possibly two thousand feet, as during the greater part of the day, they were just grazing the tops of the hills. But about three p.m. a bank of cloud began to form in this hollow much nearer the ground and half an hour later, when the thunderclap came, the light was much obscured. My opinion is that the lower cloud drew an overwhelming charge from the clouds above, and accordingly flashes sped to earth from several points at the same instant.

I have, of course, made certain that we are dealing here with one and the same thunderclap, as was not difficult to do, seeing that all the other peals of thunder were comparatively distant.

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UPS AND DOWNS OF A TELEGRAPH LINE.

(*Continued from page 612*)

developments. The peeking was excellent; so good, in fact, that it seemed wholly unnecessary to crowd the other things in that room by the addition of my presence.

The storm was nearly overhead and each succeeding flash and report was heavier than the last. Things seemed to be holding together fairly well, however, when—bing! a tremendous ripping, tearing discharge took place; and this time there began to be doings on my instrument-shelf. Hot arcs played about with a sizzling noise. The sounder tapped wildly, buzzed, stuck, and slowly grew red-hot! Smoke rose up. The batteries boiled and gave off ugly green fumes. It looked like a pocket-edition of the end of the world.

Now, if I wanted to, I could claim to have been cool in the face of disaster because what I did was quite effective. But I will not deceive you; I was rattled. I had just one thought—if the house burned down, it would be my fault, and father would be displeased and might mention the fact. I left my wits in the hall, never expecting to see them again. Rushing into the room, I seized a baseball-bat that stood in a corner and landed a three-bagger on Station B of the Continental Telegraph Company. For an instant the air was full of hot metal, burning wood, broken glass, and battery-fluid; and then there was peace. That is, if you could call it peace where the smoke was rising from a mass of varied wreckage and wild cries were exuding from the family, with their necks craned over the attic stairs.

The next morning four fathers put four feet down as one, and the Continental Telegraph Company went into liquidation without declaring a dividend. Four crestfallen Bugs were seen—in fact, were intentionally overseen—while they toted a ladder from house to house, pulling down and rolling up into history their erstwhile String of Pearls. If I have been too long in unrolling it again for you, I beg your distinguished pardon. I thank you for your kind attention.

HOW THE "WIRELESS WIZ" TURNED EVANGELIST—A XMAS STORY.

(*Continued from page 565*)

in arranging it?" he asked exasperatingly.

Thus he had started the ball rolling himself and I awaited developments with interest. The "Wiz" switched off the lights and the three of us settled down behind a like number of thoroly healthy "jimmy pipes" in front of the flaring gas log that the "Wiz" had thoughtfully installed in an imitation fireplace.

The "Wiz" appeared to be "feeding" Nolan (in the language of the classics), for he was putting up the worst argument I ever heard and leaving all kinds of openings. "Let the maw of oblivion take all this silly nonsensical rot about Christmas spirit," Polar finished just as the tiny clock on the mantelpiece struck the hour of eleven. The "Wiz" was gazing intently into the fire and Nolan followed the direction of his gaze and awaited a reply to his epithet.

In silence we sat, one—two—three minutes when—what was that! We all stiffened slightly, as faintly at first, then louder, came the sounds of sweet chimes playing that old, old wonderful hymn, "Adesta Fidelis." Quaint and mysterious it sounded as the notes rang out and reverberated through the confines of that room.

Imagine the scene. The glowing gas log faintly flooding the room with its ruddy light casting purplish-black shadows into every corner. The three of us, sitting like graven images, gazing spell-bound into the fire while every note of the wondrous music seemed to search out some corner of our inner being and finding there a responsive chord. The music had but half finished when I almost sprang from my chair in alarm, for there, above the flickering flames, slowly appeared the face of HIM who died that the world might be saved. What a wonderful spectacle—one never to be forgotten. That symbol of goodness rested before our eyes as the chimes continued their glorious, heavenly music. We moved not when the last lingering echoes had died away into a silence so intense that the faint cloud of smoke about our heads appeared as if hewn from some solid substance. Then slowly the startling image above the flames faded away into the translucent air.

Would someone but break the silence? Not a word was spoken but I noticed that Polar's hand trembled as he lit his cold pipe and enshrouded himself in a cloud of consoling smoke. Suddenly he sprang to his feet and picking up coat and hat donned them in silence. Turning to the "Wiz" he extended his hand and that shake meant more than ever could be conveyed by mere words. In his eyes as he left was the light you see in the eyes of high strung race horses, in the eyes of a red-blooded, joyful child, in the eyes of all those who strive for high things and high ideals. In silence he left.

"Wonderful," I breathed to the "Wiz" as he returned to the fireside.

"Yes, in effect but not in arrangement," he confided and seizing the edge of the fireplace he gave it a tug. It swung away from the wall slightly and motioning me to follow, he squeezed his way to the back of it.

And the secret was out. For the music he had arranged a supersensitive microphone on his aerial mast which picked up the music from the steeple of a neighboring church.

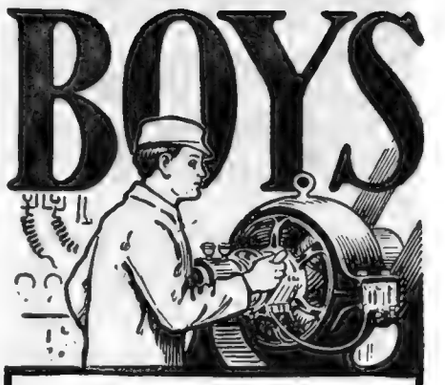
This microphone was connected to an Audion, the effect of the combination being to amplify the received sounds which, by means of a loud-talking telephone, were made audible all over the room. The little clock on the mantel was arranged to close all the circuits just three minutes after eleven o'clock.

"Where is the projection lantern that threw the face above the flames?" I asked, seeing only a concave mirror in evidence. I was trying to show how much I knew of his methods but imagine my consternation when the "Wiz" replied.

"Wrong, old man, that concave mirror did the trick. See this picture here," and he pointed to a picture similar to the one we had seen. "Well, this lamp illuminated it brightly and the concave mirror took the reflection and focused it at a point just above the gas log. No screen is necessary and the object appears to be suspended in mid-air. A fine illustration of this effect is to light a focusing electric light as used in automobile headlight in a dark room. The globes of these lamps are nearly a perfect sphere and the reflection from the inside of the glass will cause a second filament to be seen inside the globe but upside down. For this reason it was necessary to mount the picture in a reversed position so it would appear right-side up when focused."

Even when explained it yet appeared marvelous, and half-jokingly I suggested that the "Wiz" ought to become a missionary and try some of his stunts on the heathens.

"No," he solemnly replied, "we don't need heathen missionaries; we need European missionaries just now," and with these words still ringing in my ears I left —accompanied by the Wizard's *best wishes for the season.*



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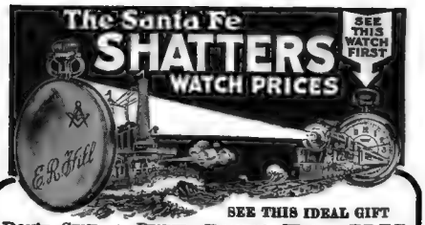

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MARVELS OF MODERN PHYSICS.

(Continued from page 567)

obtained in a sulfuric acid solution, between electrodes of a number of different metals—lead for instance. The brush removes the film deposit as soon as it collects, and allows the glow to be visible continuously. Of course it must be remembered this light is not from sparks but from a chemical source, nor is this light a practical one—far from it. The phenomenon is an actual reality, and is proof that light, with at least a negligible amount of temperature radiation can be produced.

The production of a light, equalling sunlight in diffuseness and color value has long been an unachieved goal. The carbon filament gives a yellow light, tungsten gives a whiter light, and the arc light is distinctly bluish. The nearest approach to sunlight is given us by the Moore light. This light, it will be remembered, is the vacuum tube type, that is, it consists of a long tube in which can be sealed any desired mixture of rarefied gases. A voltage of 10,000 to 12,000 causes the lamp to glow with a soft diffused light, the color of which depends on the proportion of the various gases present in the tube. Practically, it is of much use in matching colored cloths after night, but on account of its revolutionary character and high initial expense it is not in general demand. The interesting thing to note is that this is a form of low temperature radiation. It is far from being cold light in the absolute sense, but it has been found by actual measurement that the temperature inside the tube is only 30 degrees or 40 degrees C. Altho yet in its infancy, the efficiency of the Moore vacuum tube may be as high as 0.7 Watt per candle. This compares quite favorably with other lamps as may be seen from the following table:

	Watts per mear spherical Cp.
Carbon filament.....	4.00
Enclosed carbon arc.....	2.00
Moore light (neon gas)...	.70
Gas filled tungsten.....	.63
Titanium arc.....	.15

The problems of illumination embrace a consideration of the whole field of light phenomena from the physiological reactions on the eye itself, to the deeper physical and mathematical problems of the nature of light. The study of illumination is only a special case of radio transmission. We can even carry the study back to the minute electric charge—the *electron*, from which point the most fundamental distinction may be drawn between *temperature radiation and chemiluminescence*. In the former, the energy of the electron is transmitted to the whole molecule, and small light waves and larger heat waves are given off at the same time as shown in Fig. 3. The vibration of the molecule generates the heat waves, while the motion of the electron generates the light waves.

In the latter case, the energy of the electron is not communicated to the molecule and the light alone is given off (Fig. 4). This is *cold light*, in the absolute sense. In the phenomena mentioned above, the temperature radiation is not totally absent, but merely very low; and in practise it may never be possible to wholly separate the two. However, there is now but little doubt but that any great advance in the future will be along these lines, and the field is a fruitful one for research at present.

[*This is the tenth paper of a series prepared exclusively for "The Electrical Experimenter" by Mr. Rusk.—Ed.*]

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ANENT THE AUDION.

(*Continued from page 574*)

distance work. Eighteen months after the license was acquired New York and San Francisco were in voice communication. The much despised Radio Art supplied the necessary; and now watch those telephone engineers tumbling into Radio.

The Ultraudion was exhibited in 1913. Within six months Washington heard Honolulu's radio signals by daylight by its means. And to-day no long distance receiver in the world but employs, under some one of its many *aliases*, the grid audion, tho some bulbs are painted black!

And last there's the oscillating Audion or "Oscillion," as a source of high frequency generation—another of my early dreams come true—first announced in the spring of 1914. In the fall of 1915 a bank of 500 "power tubes" (Oscillions, I prefer to call them)—sent the telephone engineer's voice from Arlington a quarter of the way around the globe. And already there are being constructed single oscillion bulbs which can put one and two kilowatts in the antenna.

Here we slide into prophecy, and dare state that as a source of radio power, the Audion will play an even greater rôle than as receiver.

The little *grid* has made good.

[*Judge Learned Hand of the Federal District Court has enjoined the Marconi Wireless Telegraph Company of America from using in any form the audion detector or amplifier, the patents of which are held by the De Forest Radio Telephone and Telegraph Company. The injunction is to run perpetually and is dated October 12, 1916.*]

WITH THE AD MAN.

Greetings!

May your Christmas be a very happy and joyous one. May it be happier for the good which you can do for others and for what they are trying to do for you.

May it be happier as a result of your interest in electricity just as we are made happier by our knowledge that our efforts in introducing THE ELECTRICAL EXPERIMENTER are being appreciated.

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MILTON HYMES.

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EFFICIENT AND ECONOMICAL METHOD OF UTILIZING THE ARMSTRONG AUDION SYSTEM FOR DAMPED AND UNDAMPED WAVES.

(*Continued from page 575*)

summer, while all the spark stations along the Atlantic Coast came in very clear. The receiving station in this instance was at Quincy, Mass.

The wave length range of set "A" should be from 2,500 meters to approximately 13,500 meters, while the wave length range of set "B" should be from 200-2,500 meters. If difficulty is experienced in getting down to 200 meters, the inductance of L2 should be decreased, but not enough to destroy the coupling. Close coupling is required between L2 and L3 for good results, and if the inductance of L2 is decreased, the coupling must essentially be tightened or closed.

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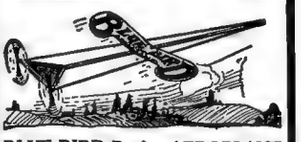

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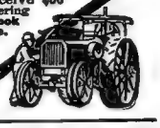

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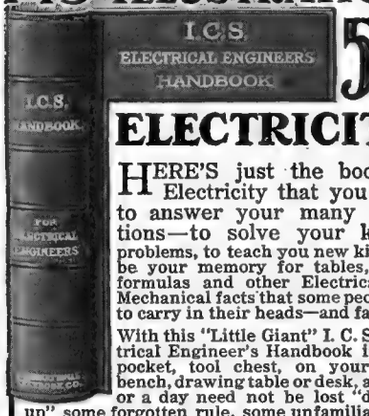

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THE DELINEATION OF INTERNAL ORGANS BY A NEW ELECTRICAL METHOD.

(*Continued from page 610*)

two-thirds the size of Screen A, and is held by wire supports (and movable along them) in the air in a horizontal position 4 or 5 feet above the center of Screen A.

The primary result of this arrangement is that any electrical field emanating from Screen A is always at right angles to that of Screen B. The fields themselves are respectively charged by the currents derived from the batteries A and B with their alternating interrupters.

Consequently, it is open to the operator to choose at will the section of the body which shall be brought within the influence of the combined electrical fields, as also the plane of the body which the lines of force in Field A shall effect.

The appliances used have now been described so far as is possible without going into minute details, but one further point must still be mentioned. At given instants of time during the operation of the appliances the current in electrode B is very unstable, consequently it has placed around it a wire coil, which insulates it from atmospheric electricity.

The Method of Operation.

The machinery thus described is operated as follows:

The first step is to place the patient in the right position in relation to the two screens. He must be quite close and head on to the vertical Screen A, and the organ to be examined must be directly under Screen B, though at a considerable distance from it, and at the same time present the desired plane towards Screen A.

The right position having been secured the following steps are taken: (1) An intact wax sheet is put upon the recording cylinder; (2) the rate at which the cylinder shall revolve is determined; (3) the appliance which regulates the rapidity of the alternations is adjusted; (4) the currents from batteries A and B are simultaneously released, with the immediate result that the recording cylinder begins to revolve while the hammer needle moves across it steadily, giving rise at each stroke to a slight click. This movement of the needle is allowed to continue until it has twice traversed the cylinder from end to end, and the currents are then cut off.

What has happened in the meantime is that the current from batterv A has reached electrode A, and has thence been projected horizontally from all parts of Screen A as an electric field. The same thing has happened in regard to the current from battery B, but the direction of the field projecting from Screen B has been vertically downwards.

What has also happened is that the two fields have met at right angles, and as they are of precisely equal strength, and are synchronized in respect of alternations, it might be expected that they would have precisely neutralized one another, and that consequently no exhibition of dynamic force would be obtainable from them.

But in practise this is not what occurs. On the contrary provided that the body under examination is that of a living person (or is one in which merely somatic, not cellular, death has occurred), an effective current from below always manages to reach electrode B and thence passes to the detector mentioned as being among the apparatus in the cupboard.

The result, therefore, has been that the hammer needle mentioned has been put into operation and has tapt out on the revolving wax sheet below it, a diagram which precisely resembles the outline of the living tissues lying vertically below Screen B.

This diagram can be discerned forthwith by holding the wax film against a strong light, and can be converted into an ordinary photograph such as those here shown by processes of a type quite familiar in various applied arts.

The Underlying Principle.

So far this account has been confined to a description of the results obtained and the machinery employed. The why and wherefore of the whole process, or rather, the underlying facts, are quite another matter.

When the results are compared with the visible means by which they are reached, they seem at first quite incomprehensible, if not incredible. It is certain, however, that they can be and are attained, so it only remains to endeavor to account for them. The inventor, it was gathered, believes that the results are primarily due to the fact that the process interposes between two alternating electric fields of equal strength—and at the precise point where they meet—a third electric field, whose facultative potential force is thus released and can be converted into dynamic power. It is this released circuit which operates the recording needle, and the pattern tapt out on the revolving cylinder varies with the shape of the organ furnishing that circuit.

The foregoing is one legitimate way of summarizing the inventor's view in simple language. Another would be to say that the force operating the needle is the balance of current which remains after the horizontal current from electrode A, reinforced by the electricity contained in the organ through which it has past, has met the descending current emanating from electrode B.

However the inventor's view be expressed, it involves the supposition that every organ in the body constitutes and originates a separate electric field, and that the facultative dynamic power of this field, as also its shape, varies precisely with the constitution and shape of each organ in question.

But, after all, very little is at present known concerning organic tissues as a source of electrical force, and in any case the fact remains that it is on this theory that the inventor and originator of the process has worked out his discovery and is at present endeavoring to perfect it in respect of mechanical details.

While the greater part of the process has been developed by constructing a novel theory and converting it into a practise, a good many of the results so far obtained are due to experiment. It has been found, for instance, that the appliances must be tuned for different organs and different tissues.

In other words, the rate of alternations in the currents, and therefore the force of each electrical impulse, must be varied according to the rate of vibration of the tissue molecules. Thus the electrical force residing in blood is very small; so, when blood vessels are to be delineated, the alternations must be very rapid. Contrariwise, since the electric force residing in heart muscle is great, the alternations must be slow when a heart is to be delineated.

The foregoing circumstance is the reason why the pictures shown in this article are so devoid of detail. In other words, the process, so far as it has at present been developed, never delineates more than one type of tissue on the same occasion, and the speed required for some tissues has not yet been learnt. This fact, however, can hardly be regarded as a total disadvantage, for from the surgical point of view it helps to make the discovery of immediate value. Take, for instance, the picture of a kidney here shown, or that of a liver. In the one

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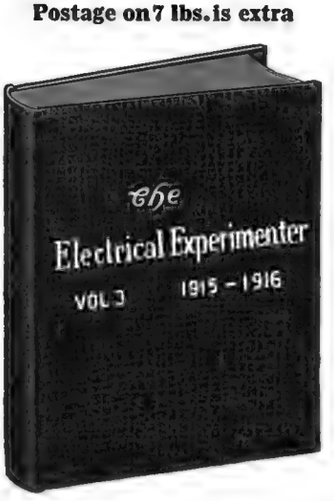

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case the instrument was tuned for kidney tissue, and in the other for liver, and in neither for blood or pus; consequently the outline of the two organs is shown quite clearly, and the effusion is represented by a patch of different tint.

So far we have not mentioned the discoverer's name. It is James Shearer, aged thirty, at present a sergeant in the Royal Army Medical Corps working at a casualty clearing station. By birth he is a Scotsman, but he received his later education in America, where he graduated M.D., Ch.M. at the University of Washington, D.C., in 1907. On his joining the R.A.M.C. he could not be given a commission, as the medical degree he holds is not one of those recognized in Great Britain, but as soon as it was found that he was possest of special electrical knowledge, and believed that he saw a way in which it could be utilized for the purposes of the war, he was given opportunities of developing his ideas by the commanding officer of the hospital of his unit (Lieutenant-colonel Clements), with the approval of the Director-general of the Medical Service in France, Sir Arthur Sloggett.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC.

Required by the Act of Congress of Aug. 24, 1912, of THE ELECTRICAL EXPERIMENTER, published Monthly at New York, N.Y., for Oct. 1, 1916:

State of New York, County of New York, ss. Before me, a Notary Public, in and for the State and County aforesaid, personally appeared Milton Hymes, who, having been duly sworn according to law, deposes and says that he is the Business Manager of THE ELECTRICAL EXPERIMENTER, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in Section 443, Postal Laws and Regulations, to wit:

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5. That the average number of copies of each issue of the publication sold or distributed, through the mails or otherwise, to paid subscribers, during the six months preceding the date shown above is—(This information is required from daily publications only.)

MILTON HYMES, *Business Manager.*

Sworn to and subscribed before me this 15th day of September, 1916.

[SEAL.] HENRY A. WALLENSTEIN,
Notary Public, New York County, No. 15.
(My commission expires March 31, 1917.)

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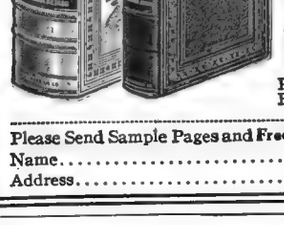

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(*Continued from page 569*)

tion night, twelve o'clock, local time.

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Station	City	State	Operato.	Wate Length	Central Time P. M.
9XE	Davenport	Iowa	Kirwan	425	10:00
9XR	Rock Island	Ill.	Karlowa	500	10:00
9YA	Iowa City	Iowa	Prof. Fort.	500	10:05
9ZS	Springfield	Ill.	Johnson	1,500	10:10
9IK	Chicago	Ill.	Mathews	200	10:15
9ADT	Milwaukee	Wis.	Hartman	200	10:20
	Lewiston	Mont.	Campbell	425	10:25
7YS	Lacey	Wash.	Ruth	425	10:20
9BD	Superior	Wis.	Keeler	200	10:35
8JZ	Cleveland	Ohio	Manning	200	10:40
8ADE	Rochester	N. Y.	Todd	200	10:45
8SK	Buffalo	N. Y.	Woodcock	200	10:50
9ZF	Denver	Colo.	Day	425	10:55
8YI	Pittsburgh	Penna.	Gilmore	500	11:00
8AEZ	Lima	Ohio	West	200	11:05
2ZB	Schenectady	N. Y.	Brooks	425	11:10
9QF	Waterloo	Iowa	Lockwood	200	11:15
	Winston-Salem	N. C.	Rothrock	200	11:20
8NH	St. Marys	Ohio	Mrs. Candler	200	11:25
9ABD	Jefferson	Missouri	Corwin	200	11:30
	Shreveport	La.	Simmons	200	11:35
5DU	Dallas	Texas	Emerson	425	11:40
8NF	Battle Creek	Mich.	House	200	11:45
9FA	St. Joseph	Missouri	Walker	200	11:50
6SL	Salt Lake City	Utah	Hart	200	11:55
6SH	Stockton	Calif.	Macquarrie	200	12:00 A. M.
1ATY	Windsor Locks	Conn.	Holcomb	200	12-05
9KT	St. Anthony	Iowa	LaPlante	200	12-10
9IC	Woodstock	Ill.	Greenleaf	200	12-15
9RK	Anderson	Ind.	Mystery	200	12:20
9ACE	St. Louis	Mo.	Shanks	200	12-25
8AOZ	Royal Oak	Mich.	Ferris	200	12:30
8CO	Grove City	Penna.	Harmon	400	12:35
3RD	Baltimore	Md.	Dimling	200	12-40
6QJ	Sawtelle	Calif.	Emmerton	200	12-45

THE REVOLVING MIRROR FOR DETERMINING SPARK CHARACTERISTICS.

(*Continued from page 573*)

focused above, this so that two images can be photographed simultaneously. In order to take a photograph of both images the incandescent electric lamp of the timing apparatus must be connected to the same key which controls the apparatus for producing the spark image which is to be measured. This is done in order to prevent a blur on the photographic plate. The plate should be exposed in the same manner as previously described. The plate is now developed and fixt in the usual manner. The time of the measured spark train is obtained by carefully projecting down two lines from the maxima of two consecutive peaks until they intersect any portion of the standard wave. Knowing the time at any interval of the standard image the corresponding time of the unknown peaks is thus readily obtained. If the standard curve has a frequency of 1,000 vibrations per second the time between two maximums would therefore be one thousandth of a second and twice this would be two thousandths of a second, and so on.

People are recognizing the value of electricity in all trades. Here is what a cabinetmaker's journal says of the electric glue pot: "While steam heat is good for glue-heating, electricity is much better. It costs little to place an electrical glue-heater in any shop. The comfort men get working in an agreeably heated glue room in summer, instead of an overheated one, in addition to the saving in fuel and the increased production, pays for an electrical equipment in less time than is often thought possible."

PROPOSING BY TELEPHONE.

Instead of annoying the girl any more why doesn't the man who proposed a thousand times set up as a teacher of the art? He ought to know how by this time, and there are millions of men that don't.—*The Sun* (*N. Y.*)

The *Sun* is wrong, says *Telephone Review.* A thousand proposals that failed are not worth one that succeeded. Better follow the example of the St. Louis man who had been proposing for five years to his inamorata without success, but who called her up when she went on a visit to Los Angeles and got her "yes" by telephone in three minutes. And it cost less than all the years of bonbons, flowers and theaters.

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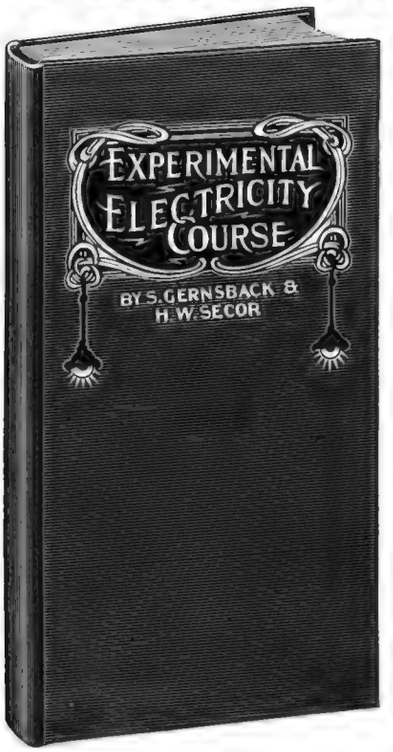

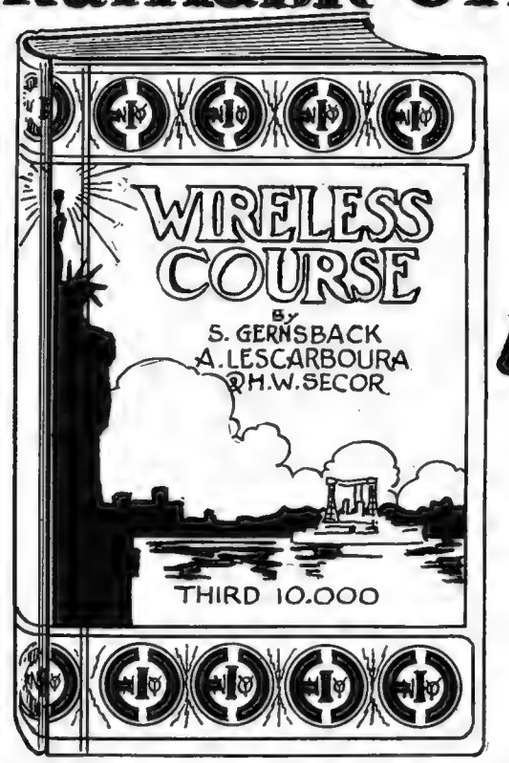

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EXPERIMENTAL CHEMISTRY.

(*Continued from page 582*)

the action that takes place. Record in your notebook.

Experiment No. 24—

Take another receiver and apply a splint in the same manner as Experiment No. 23, and while the action of combustion is going on, turn the receiver up and look into it.

Make notes of the color of the flame, and any evidence of a product.

From these tests does it appear to you that Hydrogen is a supporter of combustion? Does the splint burn in the Hydrogen, if not, what happened to it?

Comparison of the Properties of Hydrogen and Oxygen.

Let us compare the properties of both Oxygen and Hydrogen.

For comparison of the PHYSICAL PROPERTIES of these two gases we find the following:

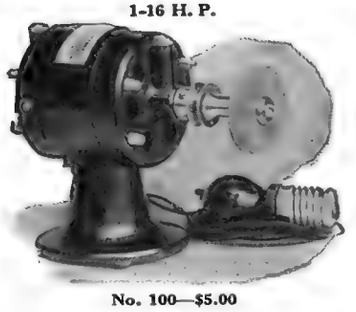
1. Both Oxygen and Hydrogen are colorless, odorless and tasteless gases.
2. Oxygen is sixteen times heavier than Hydrogen.
3. The solubility of both these gases in water are nearly the same, 100 volumes of water, dissolving 3 volumes of Oxygen, and 2 volumes of Hydrogen respectively.
4. Both gases can be liquefied.

For comparison of the CHEMICAL PROPERTIES.

1. We know that Oxygen does not combine with Bromin or Fluorin, but when Hydrogen combines with either of these two elements, namely Bromin or Fluorin, either Hydrobromic or Hydrofluoric Acid is formed.
2. We find that a splint of wood burns rapidly in Oxygen, but when placed in Hydrogen, no combustion is accomplished by introducing a lighted splint.
3. Oxygen is very essential for respiration, while Hydrogen, though non-poisonous, will not support respiration.
4. Oxygen is a powerful oxidizing agent, while Hydrogen is just the opposite—being a powerful reducing agent.

The Argentinian government has submitted to Congress a bill for the establishment of a government monopoly of wireless telegraphy in the Argentine Republic.

1-16 H. P.



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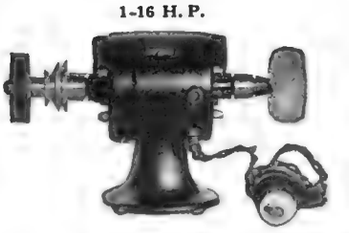

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FOR SALE—2" Manhattan Coil $3.50, brand new Murdock 2000 ohm headset $3.00 Must dispose of at once. Send for list. Henry Lehmberg, 5116 N. 12th St., Philadelphia.

Have Ferron Crystaloi, 80 ohm receiver, guitar. Want electrical books, variables, ground switch, loading coil, etc. All letters answered. F. H. Ransford, Dalton, Mass.

WANTED—An 8 volt, 10 amp. dynamo of E. I. Co.'s make. Earl Servan, Lumberton, N.J.

FOR SALE—Complete wireless set; very cheap. Will send 5 and receive up to 2,000 miles. For price and full particulars write to W. Bedell, 35 Hooker Ave., Poughkeepsie, N.Y.

FOR SALE OR EXCHANGE—Eight General Electric 110 volt alternating current arc lights cost new $25.00 each. Will sell cheap or exchange. Burgess Stewart, 222 Main Street, Huntington, W.Va.

FOR EXCHANGE—Dunduplex, Relays, Tape, Transmitter, Sounders, Combination Set, Motor, Aerial Insulators, in exchange for good Receiving Set. John Bouman, Reinholds, Pa.

FOR SALE—Modern Electrics, June 1909 to June 1914; Popular Electricity, Dec. 1909 to Nov. 1914; Electrician & Mechanic, Feb. 1910 to Jan. 1912; inclusive; first five numbers Amateur Mechanics. All first class condition. First $8.00 takes them. Leon Bryant, Camden, Me.

FOR SALE—High Power Binocular; Small Generator; water Motor. Other goods. Send for lists. A-1 Condition. Arthur Heil, 1848 Fern Ave., Easton, Pa.

FOR SALE—High class wireless outfit, sending and receiving. If you are interested in buying instruments of the best makes very cheap, no home made stuff, write, Elliott Sparling, Ashland, Wis.

FOR SALE OR EXCHANGE—Complete powerful X-Ray outfit, that will show bones thru 4 inches of pine plank. Address F. E. Austin, Box 441, Hanover, N.H.

FOR SALE—Unwound Manhattan No. 3 Motor, $1.50; Variable Condenser, $1; "Junior" Tuner, $1; 1,000 ohm Receiver and band, 75c.; 2,000 ohm Set $3; half kilowatt Transformer, $9; Condenser for same, $2.50; Edgewound strip for half kilowatt Oscillation Transformer, $1; Wireless Telegragh Construction for Amateurs, 50c. Willard Kates, Arlington Heights, Ill.

EXCHANGE—Tubular skates, new, tan shoes, size, 5-6½, with money, for ½ K.W. transmitting, rotary spark. Can't use skates, how much do you want? All letters answered. Walter Ed. Litke, 361 East 188th St., New York.

WANTED—Crystaloi, Murdock Phones, 43 plate Variable, 700' Antenium Wire, Insulators, etc. SALE OR EXCHANGE—Electric Horn, $1.85; "Boy Electrician," $1.50; Steam Engine, $3; ½" Coil, $1.40. All good as new. Glenn Kruwell, Hubbard, Iowa.

WHO HAS high power Winchester or Savage carbine to exchange for complete wireless outfit. Marconi type tuner, rubber base, 3,000 ohm phones, Clapp Eastman variable, detectors, crystals of all kinds, 600 feet phosphor bronze aerial wire, dozen electrose insulators and other wireless equipment. Outfit guaranteed. V. C. Poe, 862 Sterling Place, Brooklyn, N.Y.

PANEL RECEIVING SET—Hard rubber faced panel, Mahogany finish case, 3,000 meters. Send for further particulars and picture. Price, $125. Also pair 2,000 ohm, $4. Murdock phones, $3. Hollis Ingalls, 7 Holton St., Danvers, Mass.

FOR SALE—Complete wireless, wireless telephone. Bargain 2-55A Rheostats; 1 main switch 150 A. Many other articles. Write for particulars. Reuben Scholz, Majestic Theater, Sheboygan, Wis.

FOR SALE OR EXCHANGE—A Bi-plane Glider. What have you in Electrical goods and other lines? Would like to buy a hot air balloon. Alan Gibson, Niles, Mich.

EXCHANGE—800 meter loose coupler, almost new; cyclometer, new; inner tube, new; bicycle siren slightly used for Duplex Tel-Radion or type AA crystaloi, Tel-Radion preferred. Write Percy Vettel, Hornbrook, Cal.

WANTED—Used Hi-tone (Rotary quenched) Gap for 1 K.W. Must be in first class condition and reasonable. Cash or trade. H. J. Patterson, care General Delivery, Seattle, Wash.

FOR SALE—Electro coupler, $4; Electrolytic Interrupter, $2.20; 1,000 ohm receiver and band, $2.10; Electro key, 80c. Goods sent postpaid. James Green, Jr., Orangebury, S.C.

FOR SALE—One small 110 v. A. C. Motor, $2; Type "S" dynamo motor, $3; Gas engine magneto, $5; Electro loading coil, $2; 4 cylinder Ford coil, $4; or will trade for coupler or Blitzen 43 plate variable. What have you? Jack Gillette, Purcell, Okla.

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POST PAID—Electro Tuner, $1.25; E. S. 75 ohm Phone, 35c.; $1.50 worth of Mecanno, $1. Clarke Olney, E. Cleveland, Ohio.

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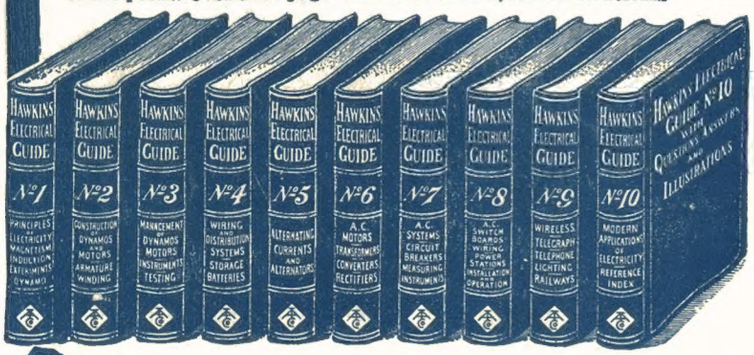

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